NEW ZEALAND.

Department of Mines.

NEW ZEALAND GEOLOGICAL SURVEY.

(P. G. MORGAN, Director.)

PALÆONTOLOGICAL BULLETIN No. 6.

THE EARLIER MESOZOIC FLORAS OF NEW ZEALAND.

BY

E. A. NEWELL ARBER, M.A., Sc.D., F.G.S., F.L.S.,

Trinity College, Cambridge; University Demonstrator in Palæobotany; Hon. Memb. New Zealand Institute.

ISSUED UNDER THE AUTHORITY OF THE HON. W. D. S. MACDONALD, MINISTER OF MINES.

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BY AUTHORITY: MARCUS F. MARKS, GOVERNMENT PRINTER.

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LETTER OF TRANSMITTAL.

Geological Survey Office,
Wellington, 1st June, 1917.

Sir,—

I have the honour to transmit herewith a palæobotanical memoir, or monograph as it may more correctly be termed, which has been written by Dr. E. A. Newell Arber, Demonstrator in Palæobotany to the University of Cambridge, and is entitled "The Earlier Mesozoic Floras of New Zealand." The memoir, now published as Palæontological Bulletin No. 6 of the New Zealand Geological Survey, contains 80 pages of letterpress, and is illustrated by 14 plates in collotype and 12 figures reproduced as half-tones or as process blocks.

A perusal of the following pages will show that Dr. Arber, who, solely as a labour of love, undertook the work of examining and describing the plant-remains here described, has spared no trouble and no pains in order to make the results of his investigations so complete that the Mesozoic botany of New Zealand will henceforward be established on a firm footing. The memoir itself will undoubtedly become a classic, indispensable to all students of Mesophytic floras.

With the exception of the plates, which were executed by the London Stereoscopic Company, this bulletin has been prepared entirely in the Government Printing Office, Wellington. Thanks and praise are due to the Government Printer and his staff for the careful manner in which this difficult typographical material has been set up. The first proof was read by Dr. Arber, but later proofs were corrected only in New Zealand, and therefore a few small errors are doubtless present. It is hoped, however, that the corrigenda will be found few in number and of little consequence.

I have the honour to be,
Sir,
Your obedient servant,
P. G. MORGAN,
Director, New Zealand Geological Survey.

Hon. W. D. S. MacDonald,
Minister of Mines, Wellington.

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PALÆONTOLOGICAL BULLETIN No. 6.

THE EARLIER MESOZOIC FLORAS

OF

NEW ZEALAND.

CHAPTER I.

INTRODUCTION.

THIS memoir is concerned with an account of the earlier Mesozoic floras of New Zealand. A large number of specimens from different localities in these islands are discussed. The geological ages of the rocks in which they occur vary from Triasso-Rhætic to Neocomian. The plant-impressions belong, for the most part, to the collections of the Geological Survey of New Zealand, of which the best examples have been forwarded to me for examination and description. Others, including recent collections from the Malvern Hills and Gore districts, are now in the Sedgwick Museum, Cambridge. A further set of fossils, to which reference is also made, is in the British Museum (Natural History) as the result of an exchange effected between that institution and the New Zealand Geological Survey in 1878.

The majority of the specimens have not been previously described. In fact, as will be seen from the next section of this memoir, very little has hitherto been attempted in regard to the fossil floras of New Zealand, other than those of the Tertiary rocks.

One result of the present work has been to show that Palæozoic plants are quite unknown from New Zealand. The many rumours of the presence of *Glossopteris*-bearing rocks in these islands have proved to be without foundation.

The fossil floras discussed here appear to be chiefly of Triasso-Rhætic or Jurassic age, several examples occurring in different regions. A very interesting Neocomian flora is described, in which the Neophytic Angiospermous types are apparently still few as compared with the Mesophytic species. For the valuable description of the Angiospermous remains included here, I am greatly indebted to my friend Dr. L. Laurent, of Marseilles.

Several new genera and species are instituted. These are indicated in Chapter III, where the flora of each locality is discussed separately. A full description of these plants will be found in Chapter VI, which contains an account of all the plants examined, arranged botanically, and irrespective of their geological ages.

I would here express my obligations to the Geological Survey of New Zealand for the loan of the collections described in the present memoir. To the Director of the Survey, Mr. P. G. Morgan, F.G.S., I am indebted for his kindness in facilitating the loan of the specimens and the publication of this memoir. I wish also to record my grateful thanks to Dr. J. A. Thomson, F.G.S., formerly Palæontologist to the Survey, for similar help, and especially for much information relating to the plant localities and to the New Zealand literature bearing upon them. The New Zealand Survey has also kindly made me a grant towards the cost of the illustrations of this memoir.

I have also to acknowledge the loan of several private collections from New Zealand. The very interesting series of plant-remains collected by the late Mr. J. S. Nicol, of Mokoia Farm, near Gore, was originally lent to me a year or two before his death. These specimens were subsequently presented by his executors to the Sedgwick Museum, Cambridge, where they are much valued.

Dr. P. Marshall, F.G.S., now of Wanganui(1), and Mr. R. Speight, F.G.S., of Canterbury Museum, Christchurch, have kindly allowed me to examine specimens in their charge. Mr. Speight has also collected for me a series of plant-remains from the Malvern Hills, which he has presented to the Sedgwick Museum, Cambridge. Several of these specimens are of interest, and are figured here. I am particularly grateful to Mr. Speight for the trouble he has taken in this matter, and also for kindly forwarding the photographs of the plant-beds at Mount Potts and in the Clent Hills for reproduction here.

To Mr. D. G. Lillie, M.A., of St. John's College, Cambridge, I am indebted for information in regard to the plant localities which he visited when in New Zealand, and especially for notes on the fossil forest of Waikawa. I am also under great obligations to him for obtaining for me the loan of specimens in New Zealand. Dr. L. Cockayne, F.R.S., has also kindly sent me copies of his photographs of the fossil forest at Waikawa, which are included here.

The photographs reproduced in the plates are the work of Mr. W. Tams, and the drawings, of Mr. T. A. Brock, both of Cambridge. The sketch-maps were drawn by the late Mr. Edwin Wilson. I am indebted to all three artists for the skill and trouble which these illustrations represent.

Lastly I would endeavour to express my sincere thanks to my friends in Stockholm, Professor Nathorst and his assistant Dr. Halle, to whose exceptional knowledge of Mesozoic plants I have appealed in several cases of difficulty. Professor Nathorst has very kindly interested himself in no small degree in these matters, and to his sound advice and wide knowledge I am particularly indebted. Thanks to his kindness, I have had an opportunity of comparing many of the New Zealand specimens here described with the rich series of Mesozoic floras of Antarctica and South America, as well as those from other localities, preserved under his care in that great "Mecca" of Palæobotany at Stockholm.

(1) Dr. Marshall is now headmaster, Wanganui Collegiate School, but until the end of 1916 was Professor of Geology at Otago University College, Dunedin. Hence the references on pages 33 and 51 of this memoir to his collection at Dunedin. – [P. G. M.]

CHAPTER II.

HISTORICAL.

The past records of Mesophytic plants from New Zealand form, with very few exceptions, a long list of *nomina nuda*—genera and species stated to be new, but neither figured nor described. In a recent note(1) I have gone very fully into these pseudo-records, which it is impossible to recognize, enumerating no less than seventy-one instances. I need not therefore deal with these matters here in detail, save to record the names of Hector(2), Ettingshausen(3), and Crié(4) as the originators of these absurdities. In fact, until the end of 1912, there were only eleven valid records of pre-Cretaceous plants from New Zealand. The number of Neophytic records is considerably greater, but with these we are not concerned here.

The earliest valid determinations from New Zealand are by Unger(5), and date from 1864. He described and figured two Wealden plants from the Waikato Heads, in Auckland, a flora redescribed here. The first of these, his *Polypodium Hochstetteri* Unger(6), is a *Cladophlebis*, allied to *C. australis* (Morr.). The other, *Asplenium palæopteris* Unger(7), I have not seen; but as the specific name can hardly stand, since it has also been used as a generic term, I should propose to term it *Sphenopteris* (? *Coniopteris*) sp., and I have elsewhere(8) compared it with the Jurassic fern *Sphenopteris Murrayana* (Brongn.). Professor Seward(9) has regarded it as identical with the Wealden *Sphenopteris Fittoni* Sew.

The three other specimens from Pakawau, Massacre (or Golden) Bay, in the Province of Nelson, figured by Unger, are very obscure fragments, and these records may be neglected. One of them is a *Cladophlebis* sp.

Hector(10) in 1886 figured, but did not describe, seventeen species from three important plant-bearing localities in New Zealand, the floras of which are dealt with in the present memoir. Some of these are small fragments, identical either with one another or with plants earlier described from other parts of the world. In several cases the names were already preoccupied(11). I have already discussed each record at some length elsewhere(8), and I need only give here my conclusions in summary form. Of Hector's seventeen species only two stand as new, while six others are first records from New Zealand. These, despite the absence of descriptions, I regard as valid.

There are first of all eight records from the Clent Hills, which I have revised as follows:—

Hector's Name.		Revised Nomenclature.
Asplenites rhomboides Hect.	.. =	*Thinnfeldia* sp.; cf. *T. argentinica* (Gein.).
Pecopteris acuta Hect. ..	.. =	*Cladophlebis* sp.
Pecopteris linearis Hect.	.. =	*Cladophlebis australis* (Morr.).
Vertebraria novæ-zealandiæ Hect.	.. =	? (Wrong generic determination, very obscure).
Taxites maitai Hect. ..	.. =	*Elatocladus conferta* (O. & M.).
Pecopteris ovata Hect. ..	.. =	*Cladophlebis* sp.
Pecopteris obtusata Hect.	.. =	*Cladophlebis* sp.
Camptopteris incisa Hect.	.. =	*Dictyophyllum acutilobum* (Braun).

(1) Arber (1913[2]); see also Thomson (1913).
(2) Hector (1870), (1878[1]), (1879[1]), (1879[2]), (1886[1]).
(3) Ettingshausen (1887[1]), (1887[2]), (1890).
(4) Crié (1888); see also (1889).
(5) Unger (1864).
(6) Unger (1864), pl. ii.
(7) Unger (1864), pl. i, figs. 4–8.
(8) Arber (1913[2]), p. 125.
(9) Seward (1894), p. xxxiii.
(10) Hector (1886[1]), text-figs. 30, 30A.
(11) I have given a list of these in Arber (1913[2]), p. 126.

Next there are six records from Mataura Falls, in Southland :—

Hector's Name.		Revised Nomenclature.
Macrotæniopteris lata Hect.	.. =	*Tæniopteris crassinervis* (Feist.).
Lomarites pectenata Hect.	.. =	*Microphyllopteris pectinata* (Hect.).
Taxites manawao Hect.	.. =	*Pagiophyllum peregrinum* (L. & H.).
Pterophyllum matauriensis Hect...	=	*Ibid.*
Sphenopteris asplenoides Hect.	.. =	*Sphenopteris* sp.
Taxites kahikatea Hect...	.. =	?

Lastly we have three species from Waikawa, in Southland :—

Hector's Name.		Revised Nomenclature.
Taxites manawao Hect...	.. =	*Palissya tenuifolia* (McCoy).
Pecopteris grandis Hect.	.. =	*Cladophlebis australis* (Morr.).
Asplenites palæopteris Unger	.. =	*Sphenopteris* (? *Coniopteris*) sp.

In 1889 Crié(1) described two petrifactions from Mataura and Toitoi :—

Crié's Name.		Revised Nomenclature.
Psaronius Huttonianus Crié	.. =	*Osmundites* sp.(2).
Araucarioxylon australe Crié	.. =	*Ibid.*

In 1907 Kidston and Gwynne-Vaughan(3) described two very interesting Osmundaceous stems from "near Gore, Otago," as *Osmundites Gibbiana* K. & G.-V., and *O. Dunlopi* K. & G.-V. These are among the few petrifactions as yet known from New Zealand, and were no doubt really derived from Curio Bay, Waikawa. More recently Sinnott(4) has also discussed similar specimens.

Prior to the commencement of the present work we therefore find that there were only eleven valid records of Mesophytic plants from New Zealand, as follows :—

Cladophlebis australis (Morr.).
Dictyophyllum acutilobum (Braun).
Microphyllopteris pectinata (Hect.)
Osmundites Dunlopi K. & G.-V.
Osmundites Gibbiana K. & G.-V.
Elatocladus conferta (O. & M.).
Palissya tenuifolia (McCoy).
Pagiophyllum peregrinum (L. & H.).
Pterophyllum matauriensis Hect.
Tæniopteris crassinervis (Feist.).
Araucarioxylon australe Crié.

In a preliminary note(5), published in 1913, on the fossil plants of the Mount Potts beds I figured the following species, among others, indicated as occurring in this locality :—

Linguifolium Lillieanum sp. nov.
Baiera cf. *B. paucipartita* Nath.
Tæniopteris Daintreei McCoy.
Chiropteris lacerata sp. nov.
Thinnfeldia lancifolia (Morr.).

These plants are both described and refigured in the present memoir, in order to render the account of the New Zealand floras as complete as possible.

(1) Crié (1889).
(2) Kidston and Gwynne-Vaughan (1916), p. 479.
(3) Kidston and Gwynne-Vaughan (1907).
(4) Sinnott (1914).
(5) Arber (1913[1]).

CHAPTER III.

A REVIEW OF THE LOCALITIES, WITH A SYNOPSIS OF THE COLLECTIONS AND PREVIOUS RECORDS; AND A DISCUSSION AS TO THE GEOLOGICAL AGE OF THE BEDS.

I propose in the present chapter to consider the localities from which the fossil plants dealt with here were obtained. These will be enumerated roughly in order of their geological age, beginning with the most important of the older Triasso-Rhætic floras, and concluding with the single Neocomian plant-assemblage. In addition to details relating to the localities and the collections made from them, with an enumeration of previous records, I have also added a list of the species described here. Previous opinions in regard to the geological age of the beds are next considered, and finally in each case the conclusions which I have arrived at on this point are stated.

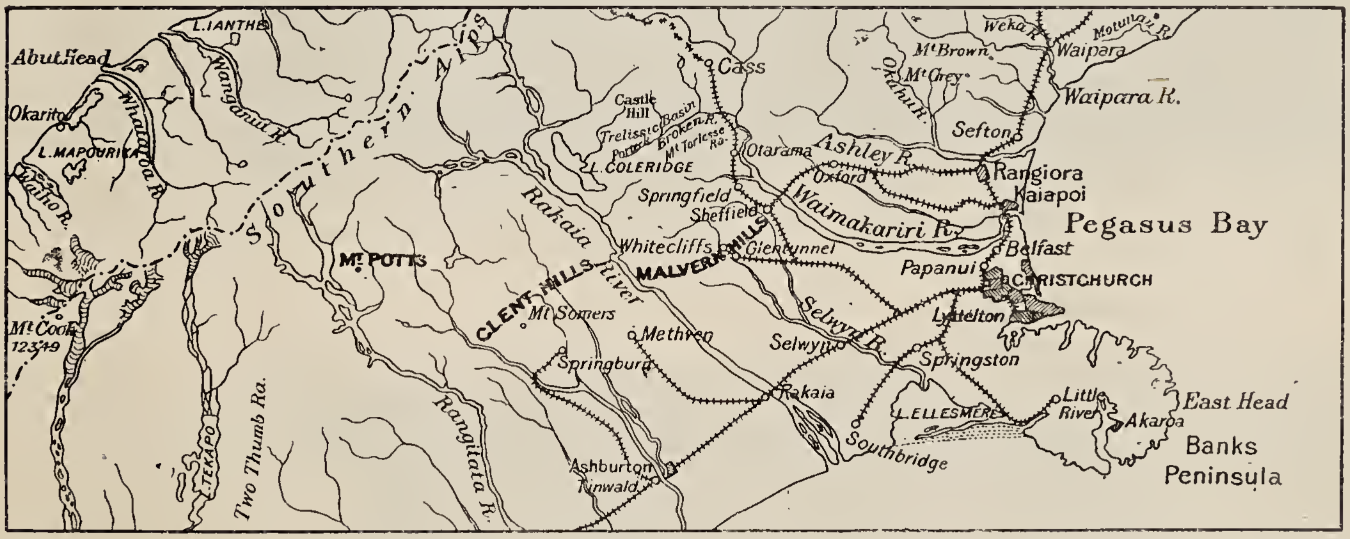

Fig. 1. Sketch-map of the Canterbury District, South Island, showing the Relative Positions of the Plant Localities at Mount Potts, and in the Clent and Malvern Hills.

A. The Rhætic Flora of Mount Potts (Canterbury).

Locality.—Mount Potts, situated in Ashburton County, Canterbury, is part of a mountain-range lying between the upper Rangitata River on the south-west (fig. 1) and the upper Rakaia River on the north-east, and drained by the upper Ashburton River on the south-east. Mount Potts itself, a snow-covered mountain 7,197 ft. in height, is almost isolated from the range by the Potts River, which flows south and west to join the Rangitata River. The fossiliferous localities (figs. 2, 3) lie on the western slopes of Mount Potts, principally in Rocky (or Fossil) Gully (the faunal locality) and in Tank Gully (the plant locality), the small streams of which flow westward to the Clyde River, a branch of the upper Rangitata.

The beds here consist of a great thickness of dark shales, alternating with thinner layers of sandstone. They form a large anticlinal fold in Fossil Gully, where they are well exposed for several miles.

The Collections.—The first fossils found in these beds were Spiriferinas and other brachiopoda (see p. 6), discovered by Haast (afterwards Sir Julius von Haast) in 1861.

Plants were first obtained from associated beds by McKay(1) in 1878. The New Zealand Geological Survey collection, however, apparently contains only a very few fragmentary specimens from this locality. The material described here was collected from Tank Gully in November, 1911, by Mr. D. G. Lillie, of Cambridge, as the result of a journey to Mount Potts, in company with Mr. R. Speight, F.G.S., of Christchurch.

Previous Records.—Hector(2), in 1878 and in subsequent years, recorded "*Glossopteris augustifolia* and *Schizoneura* sp." from these beds, but no figures or descriptions of the specimens were ever published by him.

Ettingshausen(3), in 1887, recorded seven species of the genera *Equisetum*, *Tæniopteris*, *Asplenium*, *Palissya*, *Baiera*, *Thinnfeldia*, and *Protocladus*, six of which were new, but no figures or descriptions were given of any of them, and they remain mere *nomina nuda*.

As stated in the previous chapter, in 1913(4) I figured the following plants collected by Mr. Lillie from Mount Potts. These are now in the British Museum (Natural History):—

Linguifolium Lillieanum sp. nov.
Baiera cf. *Baiera paucipartita* Nath.
Tæniopteris Daintreei McCoy.
Chiropteris lacerata sp. nov.
Thinnfeldia lancifolia (Morr.).

For the sake of completeness, these specimens are refigured here, and a full description of them is also added. Two modifications have been made in the list of determinations, both the *Baiera* and the *Tæniopteris* being now regarded as new species, viz.:—

Baiera robusta sp. nov.
Tæniopteris Thomsoniana sp. nov.

Previous Opinions with regard to the Age of the Mount Potts Beds.—The nature of the flora of the Mount Potts beds, and the question of its geological age, have been the subjects of much controversy in New Zealand, particularly between Hector and Haast, and consequently considerable doubt has existed in Europe on these questions. The matter has been complicated by the fact that, sixteen years before the first plant-remains were discovered at Mount Potts, certain beds of mollusca, brachiopoda, and isolated saurian(?) bones were found in the same locality. Further, some fifteen miles distant, in the Clent Hills, plant-remains were also known, which Haast(5) regarded on stratigraphical evidence as occurring in beds of equivalent age to those bearing mollusca at Mount Potts, originally discovered by him in 1861.

The marine fauna from Mount Potts and the plants from the Clent Hills had been submitted to McCoy, who pronounced the former to be Lower Carboniferous or Devonian, and the latter Jurassic in age(6). Haast, however, disagreed with the age assigned to the Clent Hill flora, and explicitly states that the same beds which contain the flora in the Clent Hills overlie the molluscan beds at Mount Potts. He adds(5), "This is therefore good and, as I think, conclusive evidence that the Clent Hills and Malvern Hills plant-beds, notwithstanding they contain the remains of a plant closely allied to *Tæniopteris*, are nevertheless of great age, and, if we adopt

(1) McKay (1878[1]).
(2) Hector (1878[1]), p. iv, and McKay (1878[1]), p. 106.
(3) Ettingshausen (1887), p. 147.
(4) Arber (1913[1]).
(5) Haast (1877), p. 6.
(6) Hector (1877), p. v; Haast (1877), p. 6; and especially McCoy in Hector (1886[2]), p. xxi, footnote.

Fig. 2. The Plant-bearing Beds of Tank Gully, Mount Potts.

[R. Speight, F.G.S., photo.

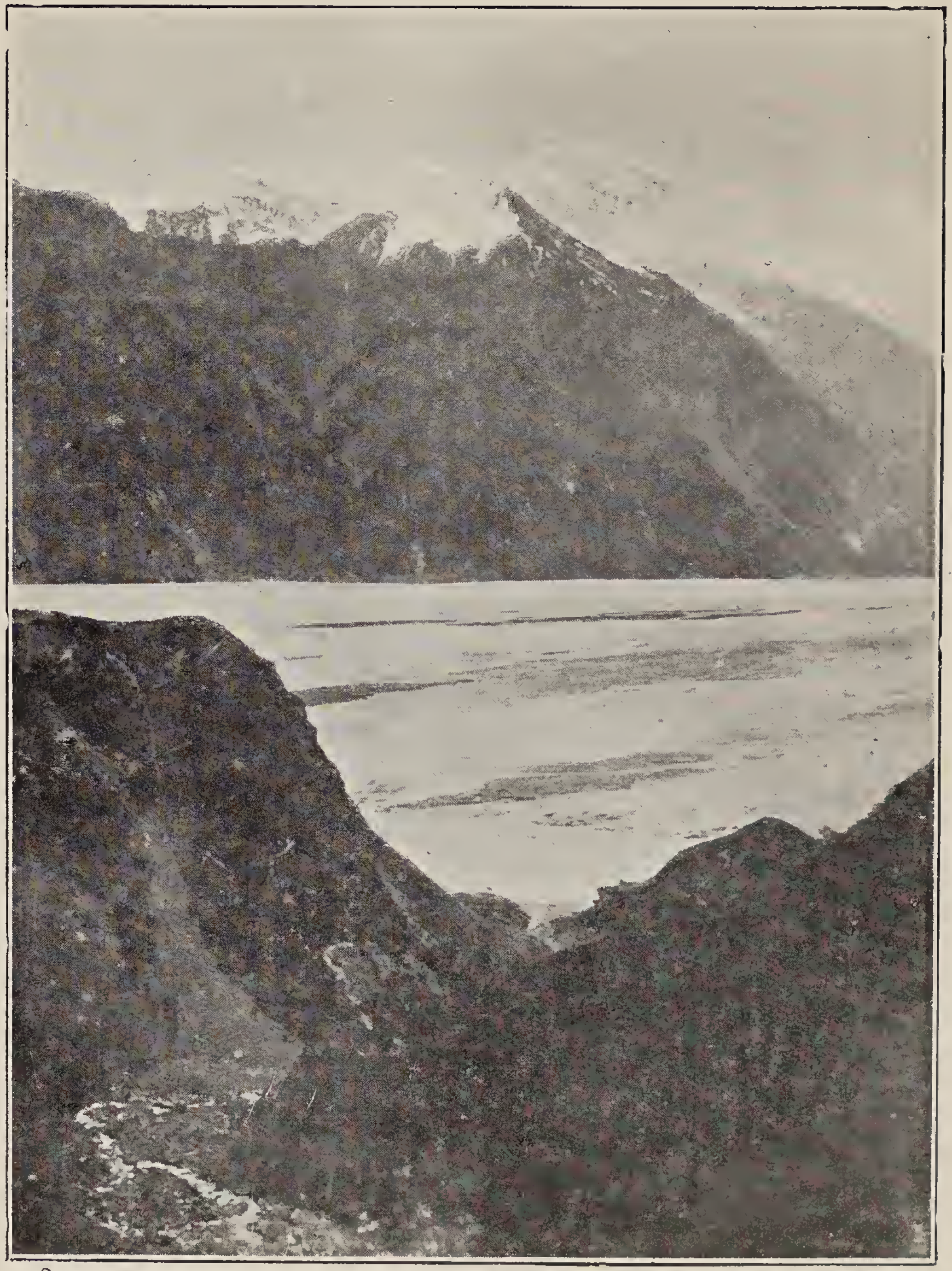

Fig. 3. Tank Gully, Mount Potts, looking down to the Clyde River.

[R Speight, F.G.S., photo.

Professor McCoy's conclusions for the Mount Potts fossil shells, at least Carboniferous. Moreover, there is no doubt that they are of the same age as the formations which in New South Wales contain the fine coalfields."

Thus Haast clearly regarded the whole series as of Palæozoic age. This conclusion, published in 1877, began a controversy which lasted for several years, in which Hector was Haast's chief opponent. Hector(1), speaking of Haast's report, said, "I have to state that the *Pecopteris*, *Tæniopteris*, and *Camptopteris* [of the Clent Hills] mentioned by Dr. Haast are all quite different in appearance from the Australian species, but the same species have been obtained in the Waikara beds in Otago, which are certainly not Palæozoic, but of the same age as the Mataura Series. The negative evidence adduced cannot be considered of much value, and it is advisable to reserve opinions on the question of the relations which exist between these plant-beds of the Clent Hills and the Mount Potts Spirifer beds until more direct evidence can be obtained than we are at present in the possession of."

McKay's visit(2) to Mount Potts in 1878 resulted not only in the discovery of a fossil flora in the beds exposed in Tank Gully, but also in a new interpretation of the succession, which has in the main been confirmed by Park(3) more recently. McKay obtained the fossil plants from shales occurring 2,000 ft. below those containing the marine fauna(4). Hector(5) described the plants collected by McKay as "*Glossopteris augustifolia* and *Schizoneura* sp.," and stated that the beds at Mount Potts are "full of the leaves of the *Glossopteris*"(6). Hector's assertion that *Glossopteris* occurs at Mount Potts was repeated from time to time. In 1886 he gave a general review of the position of the controversy(7). In the same year he also stated that "at the base of the Kaihiku Series are the *Glossopteris* beds of Mount Potts; but these were not found in the Hokanui section, although from the thickness of the strata the relative beds must be included in it; while in the Kaihiku district *Glossopteris* occurs in the lower beds as developed in Popotunoa Gorge"(8).

It is unnecessary to follow the controversy(7) further here. The position may be summed up as follows: Haast regarded the marine fauna and plant-beds of Mount Potts as of the same age as the plant-bearing series in the Clent Hills, and that age as Carboniferous. Hector(9) asserted that the Mount Potts flora was either Carboniferous or Permian, but that the Clent Hill beds were Jurassic.

At one time in Europe it appeared probable that in Mount Potts we might have a similar succession to the lower part of the Permo-Carboniferous sequence of New South Wales, where marine horizons, containing Upper Carboniferous mollusca, alternate with estuarine beds containing *Glossopteris*. This would accord with McCoy's conclusions as to the fauna and Hector's view of the flora of Mount Potts. The obvious difficulty to this belief was the association of vertebrate bones, believed to be those of saurians, with this fauna, and this association naturally played a considerable part in the discussion in New Zealand.

I may perhaps anticipate the results of the present examination here to complete the story. There is little doubt that Haast, McCoy, and Hector were all three mistaken in their conclusions as to the age of these beds. The flora of Mount Potts proves

(1) Hector (1877), p. vi. For "Waikara" read "Waikawa." (See Table of Errata in publication cited.)
(2) McKay (1878¹). See also Hector (1878¹), p. iv; Hector (1878²), p. 533.
(3) Park (1904), p. 388.
(4) McKay (1878¹), p. 106.
(5) Hector (1878¹), p. iv.
(6) Hector (1878²), p. 533. The earliest reference to *Glossopteris* in New Zealand is by Hector in 1869, from the Hokanui Mountains—Hector (1869), p. iii.
(7) Hector (1886²).
(8) Hector (1886¹), p. 77.
(9) Hector (1886¹).

to be Rhæto-Liassic, and perhaps a little older than that of the Clent and Malvern Hills floras. Haast's main contention, however, that the two floras of Mount Potts and the Clent Hills were not separated by any great interval of time, is confirmed. But, so far, none of the plants from the Mount Potts beds have been described or figured. In 1887 the first specimens were submitted to an European palæobotanist, Ettingshausen(1). He recorded seven species from these beds, all new except the *Polypodium Hochstetteri* of Unger. None of the new types, however, were figured, much less described, and these names remain to this day discredited *nomina nuda.* Ettingshausen regarded the age of the beds as Triassic.

In 1912 I published two preliminary notes(2) having reference to this flora, in which I pointed out that the age of the flora was either Rhætic or Lower Jurassic, and that *Glossopteris* itself does not occur(3).

Conclusions as to the Age of the Beds.—The following is a list of the records from Mount Potts which are described here :—

EQUISETALES—
- *Phyllotheca minuta* sp. nov.

FERN-LIKE PLANTS—
- *Linguifolium Lillieanum* Arber.
- *Chiropteris lacerata* Arber.
- *Dictyophyllum acutilobum* (Braun).
- *Cladophlebis australis* (Morr.).
- *Thinnfeldia lancifolia* (Morr.).
- *Tæniopteris Thomsoniana* sp. nov.

GINKGOALES—
- *Baiera robusta* sp. nov.

CONIFERALES—
- *Elatocladus conferta* (O. & M.).

Of the nine determinations from this locality, five are new species. Of the latter, the genus *Chiropteris* is, so far as we know, wholly Rhætic. *Phyllotheca,* in the Mesozoic rocks, is also much more abundant in the Triassic than in the Jurassic. *Linguifolium* has been previously recorded from both the Rhætic and Jurassic. *Tæniopteris Thomsoniana* and *Baiera robusta* are closely similar to Rhætic species.

As regards the other determinations, *Dictyophyllum acutilobum* and *Thinnfeldia lancifolia* are essentially Rhætic. *Cladophlebis australis* has a wide range, from the Rhætic to the Lower Cretaceous. *Elatocladus conferta* has been previously recorded only from Jurassic rocks.

Thus we see that the affinities of the Mount Potts flora strongly indicate a Rhætic rather than a Jurassic age. At the present time it is, however, impossible to distinguish between a Rhætic and Liassic flora. In this instance at least two essentially Jurassic types occur, and one must therefore admit the possibility of a Liassic age. At the same time I am, on the whole, inclined to regard the Mount Potts flora as essentially Rhætic, and base that opinion especially on the occurrence of *Chiropteris* and *Thinnfeldia lancifolia.* It certainly has very strong affinities to other floras usually termed Rhætic; and the occurrence of one or two types hitherto only known from the Jurassic is not of great moment in this connection, seeing that many plants are already known to be common to the two floras.

Age.—Rhætic.

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(1) Ettingshausen (1887[1]), (1887[2]), (1878[3]), (1890).

(2) Arber (1913[1]), (1913[2]).

(3) See also pp. 1, and 20–22.

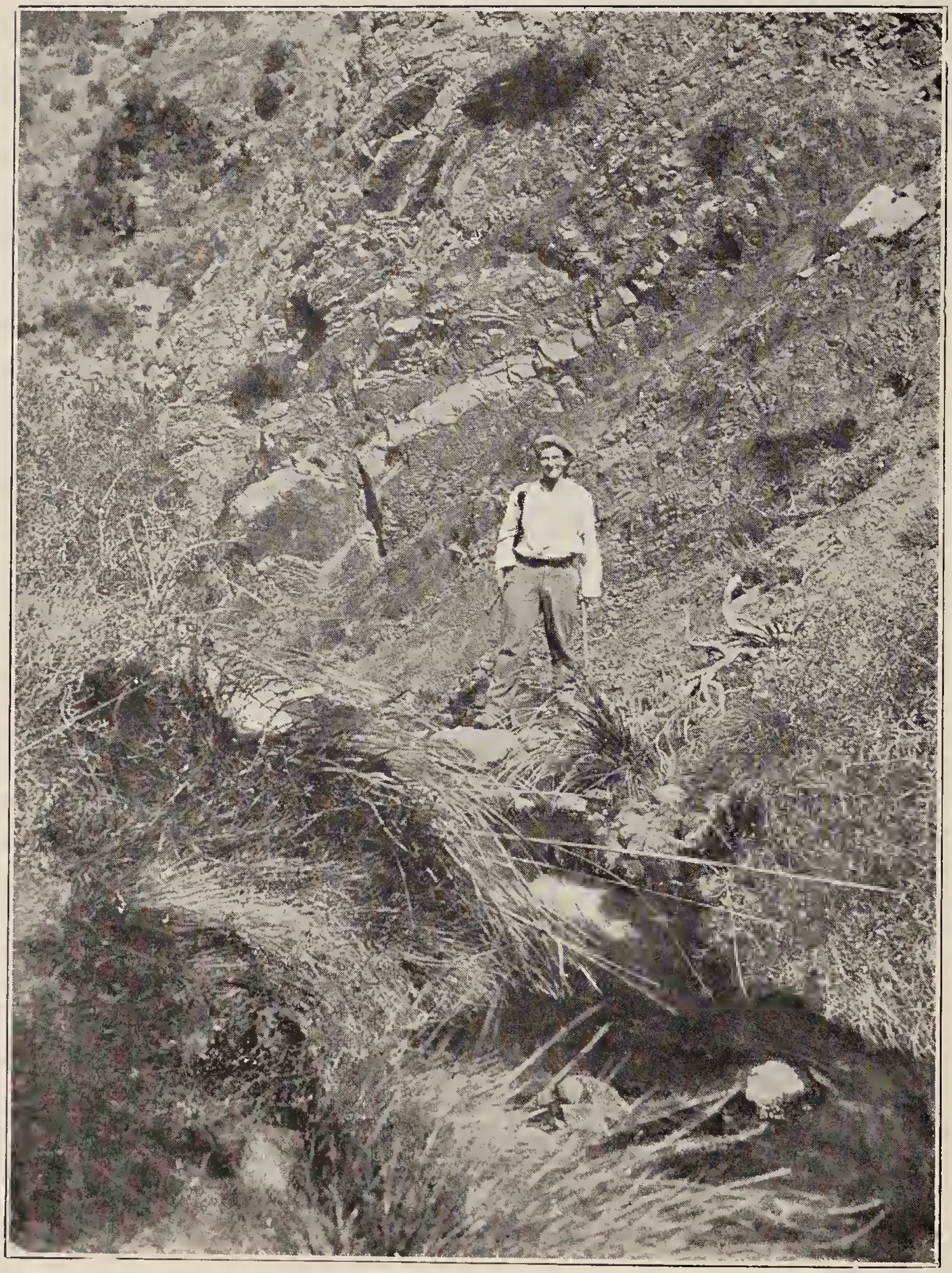

Fig. 4. The Plant-bearing Beds in the Clent Hills.

[*R. Speight, F.G.S., photo.*]

B. The Rhætic Flora of the Clent Hills (Canterbury).

Locality.—The Clent Hills lie some distance to the west of Christchurch (see map, fig. 1), but not so far to the west as Mount Potts. The beds occurring there have been described by Haast(1).

The Collections.—Fossil plants were first discovered in this locality by Haast(1), and his specimens are no doubt included in the large Survey collection from this locality. Another but smaller collection has been for many years in the British Museum (Natural History). The specimens, as a rule, however, are fragmentary, and but rarely clearly preserved.

Previous Records.—The only previous records(2) from the Clent Hills, other than mere *nomina nuda*, are eight specimens figured by Hector(3) in 1886. The first of these, *Asplenites rhomboides* Hect., is a small fragment of *Thinnfeldia* sp., perhaps *T. argentinica* (Gein.). The *Pecopteris acuta* and *P. linearis* of Hector are fragments of fronds of *Cladophlebis australis.* The *Vertebraria novæ-zealandiæ* Hect. is a wholly obscure fossil, presenting no similarity to any known species of *Vertebraria.* A small leaf-sheath of a *Phyllotheca* is, however, seen on the same specimen, and is also figured by Hector. The *Taxites maitai* of Hector is a small fragment of *Elatocladus conferta* (O. & M.). Further fragments of *Cladophlebis* are also figured under the names *Pecopteris ovata* Hect. and *Pecopteris obtusata* Hect. Hector's *Camptopteris incisa* is *Dictyophyllum acutilobum* (Braun).

Previous Opinions as to the Age of the Beds.—Haast's(4) conclusions on this point have been already quoted on pages 6–7.

Conclusions as to the Age of the Beds.—The following is a list of the determinations included here from the Clent Hills :—

Equisetales—
- *Phyllotheca minuta* sp. nov.

Fern-like Plants—
- *Thinnfeldia odontopteroides* (Morr.).
- *T.* sp. cf. *T. argentinica* (Gein.).
- *Cladophlebis australis* (Morr.).
- *Dictyophyllum acutilobum* (Braun).
- *Tæniopteris Daintreei* McCoy.
- *T. Thomsoniana* sp. nov.

Coniferales—
- *Elatocladus conferta* (O. & M.).

It is obvious that this flora is closely related to that of the Mount Potts beds, the records of which are enumerated on page 8. The species *Tæniopteris Daintreei* McCoy is an essentially Jurassic plant, which may, however, also occur in the Rhætic, while the doubtful attribution, *Thinnfeldia argentinica* (Gein.), is unknown from the Mount Potts beds(5). Otherwise all the Clent Hills fossils are identical with plants occurring at Mount Potts. At the Clent Hills, however, no trace of the genera *Linguifolium*, *Chiropteris*, or *Baiera* has been found. Nevertheless I conclude that the age of the beds, as at Mount Potts, is Rhætic, though the Clent Hills beds may be slightly younger in age than those of the former locality.

Age.—Rhætic.

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(1) Haast (1872[2]), (1877).

(2) Haast (1877), p. 4, recorded *Pecopteris* (two or three species), *Camptopteris*, *Tæniopteris*, *Otopteris*, *Cyclopteris*, *Sphenopteris*, and other genera from this locality.

(3) Hector (1886[1]), pp. 65–66, figs. 30–30A. Also Arber (1913), p. 126.

(4) Haast (1877), p. 6.

(5) *Thinnfeldia odontopteroides* (Morr.) is also at present unknown from the Mount Potts beds.—[P. G. M.]

C. The Rhætic (?) Flora of the Hokonui Hills, Southland.

Localities.—Two plant-bearing localities occur in the Hokonui Hills(1) in Southland (see map, fig. 5) at McRae's Farm, Makarewa, and at Hedgehope respectively.

The Collections.—The specimens in the New Zealand Survey collection were obtained by Park in 1887(2).

Previous Records.—The Makarewa beds are described by Park(2) as consisting of sandstones and conglomerates, with one bed of shale. "The argillaceous shales (No. 5) contain thin seams of coal and numerous distinct fossil plants, of which a large number were collected, embracing *Pecopteris grandis,* Asplenites, Taxites, and two species of small *Tæniopteris.* The brown sandstones contain large indistinct plant-remains and fragments of silicified wood."

Conclusions as to the Age of the Beds.—The following are the records from the Hokonui Hills, Southland :—

Fern-like Plants—

Cladophlebis australis (Morr.).
Tæniopteris Daintreei McCoy.
Thinnfeldia lancifolia (Morr.).
Sphenopteris sp.

Coniferales—

Cryptomerites sp.

There is little doubt that this flora indicates either a Rhætic or an early Jurassic age, but unfortunately it is not nearly large enough to afford satisfactory evidence as to which of these two alternatives is the more correct. It may perhaps be termed, for the present, Rhætic (?).

Age.—Rhætic (?).

D. The Rhætic (?) Flora of Owaka Creek, Catlin's River, Otago.

Locality.—In Otago at Owaka Creek(3), a branch of the Catlin's River (see map, fig. 5), plants occur on several horizons, in a series of beds which have been described by McKay(4).

The Collections.—The specimens in the New Zealand Survey collection were chiefly obtained by McKay in 1873 at Old Mill, Owaka Creek. An earlier collection, formed by Hector in 1865, has also been examined.

Conclusions as to the Age of the Beds.—The following species are recorded here :—

Fern-like Plants—

Cladophlebis australis (Morr.).
Tæniopteris Daintreei McCoy.
Thinnfeldia lancifolia (Morr.).
Thinnfeldia odontopteroides (Morr.).
Thinnfeldia Feistmanteli ? (Goth.).
Sphenopteris owakaensis sp. nov.
S. otagoensis sp. nov.
Microphyllopteris sp.

Coniferales—

Brachyphyllum sp.

(1) This name is also spelt "Hokanui," as in map, fig. 5.
(2) Park (1887), pp. 145, 146.
(3) The name was formerly but incorrectly spelt "Owake."
(4) McKay (1877), pp. 59–73.

Here again the number of records, ignoring the new species, is very scanty, and the choice lies between Rhætic and Lower Jurassic. On the whole I am inclined to assign these beds provisionally to the earlier formation, on account of the abundance of the genus *Thinnfeldia*, but this conclusion may well require revision should a better collection be some day forthcoming.

Age.—Rhætic (?).

E. The Jurassic Flora of the Malvern Hills, Canterbury.

Locality.—The Malvern Hills lie some forty miles to the west of Christchurch, and contain the headwaters of the Selwyn and other rivers (see fig. 1). The sediments there developed were described by Hector(1) in 1871, and by Haast(2) in 1871 and 1872.

The Collections.—The specimens described here are in a collection specially made for this revision of the New Zealand Mesophytic floras by the kindness of Mr. R. Speight, F.G.S., who visited the Malvern Hills for this purpose. These were subsequently presented by Mr. Speight to the Sedgwick Museum, Cambridge. I have also, through Mr. Speight's good offices, had an opportunity of examining a collection from the same locality belonging to the Canterbury Museum, Christchurch.

Previous Records.—Haast(3) has recorded *Pecopteris* sp., *Tæniopteris* sp., and *Camptopteris* sp. from this locality.

Previous Opinions as to the Age of the Beds.—Haast in 1871 said the "lowest visible beds consist of conglomerates, coarse sandstones, and shales, with *Pecopteris*, *Tæniopteris*, and other remains of plants, which, according to Professor McCoy, are identical with those obtained in the coalfields of New South Wales, and are probably of Carboniferous age"(4). In 1872 Haast(5) also inclined to a Palæozoic attribution.

Conclusions as to the Age of the Beds.—The flora of the Malvern Hills is a small one, consisting of the following species:

Fern-like Plants—
- *Linguifolium Lillieanum* Arber.
- *Cladophlebis australis* (Morr.).
- *C. denticulata* (Brongn.).
- *Tæniopteris Daintreei* McCoy.
- *Coniopteris hymenophylloides* (Brongn.).
- *Sphenopteris* sp.

Coniferales—
- *Elatocladus conferta* (O. & M.).

There is little doubt that the age is either Rhætic or Lower Jurassic. On the whole, I should be inclined to refer this flora to the latter period. Several of the above species, such as *Tæniopteris Daintreei* McCoy, the two species of *Cladophlebis*, and *Elatocladus conferta*, appear to occur both in Rhætic and Jurassic rocks in New Zealand. *Linguifolium* appears to be rare in the Malvern Hills beds. It only occurs abundantly in one other locality in New Zealand—Mount Potts—here referred to the Rhætic, though from Australia and Europe it is known in Jurassic sediments.

(1) Hector (1871).
(2) Haast (1871), p. 135; (1872[1]), p. 1.
(3) Haast (1871), p. 136; (1872[1]), pp. 6–7.
(4) Haast (1871), p. 136.
(5) Haast (1872[1]), p. 6.

In *Coniopteris hymenophylloides,* however, we have a thoroughly Jurassic type. There is also a general absence of many of the common plants met with in the Rhætic of Mount Potts and the Clent Hills. I am therefore inclined to place the Malvern Hills beds low down in the Jurassic, though, were a more extensive flora known from them, this conclusion might well require revision.

Age.—Lower Jurassic (?).

F. The Jurassic Flora of Mokoia, near Gore, Southland.

Locality.—The late Mr. J. S. Nicol's farm, Mokoia, lies four and a half miles south of Gore(1), on the left bank of the Mataura River, and about one and a quarter miles east of the river, between the towns of Gore and Mataura (see map, fig. 5).

The Collections.—About ten years ago the late Mr. J. S. Nicol began to collect such specimens as could be obtained from time to time when fresh exposures were made on the farm, and on his death in 1914 his executors presented his collection to the Sedgwick Museum, Cambridge. No plant-remains have previously been recorded from this locality. The geology of the neighbourhood of Gore and Mataura was described by McKay(2) in 1881.

Previous Opinion as to the Age of the Beds.—McKay(3) referred these beds to the Trias. Those on the east bank of the Mataura River opposite Gore he termed the Wairoa Series or Middle Trias, those on the same bank between Mataura and Gore the Otapiri Series or Upper Trias.

Conclusions as to the Age of the Beds.—The following is a list of the fossils here described from Mokoia Farm:—

Equisetales—
- *Equisetites Nicoli* sp. nov.

Fern-like Plants—
- *Dictyophyllum obtusilobum* ? (Braun).
- *Thinnfeldia* sp.
- *Coniopteris hymenophylloides* (Brongn.).
- *Sphenopteris (Ruffordia) Gœpperti* Dunk.
- *S. gorensis* sp. nov.
- *S. Currani* ? (Ten.-Woods).

Cycadophyta—
- *Nilssonia compta* ? (Phill.).
- Pinnule of a Cycadophyte.

Coniferales—
- *Elatocladus conferta* (O. & M.).
- *Stachyotaxus* ? sp.
- *Araucarites cutchensis* Feist.

I regard this flora as probably of Lower Jurassic age. *Coniopteris hymenophylloides* and *Nilssonia compta* are species abundant in the Lower Oolite (Middle Jurassic) of Britain. *Equisetites Nicoli* sp. nov. is closely similar to a species which also occurs on this horizon in Scotland. *Sphenopteris (Ruffordia) Gœpperti* ranges from the Jurassic to the Wealden, but has been recorded from the Middle Jurassic of Grahamland and England. The Jurassic affinity of the flora is thus clear. *Sphenopteris Currani* occurs on an unknown horizon of the Jurassic of Australia.

On the other hand, *Dictyophyllum obtusilobum* is only known from the Rhætic, and *Stachyotaxus* is apparently confined to this horizon, if we except certain doubtful

(1) Though both Mokoia Farm and Gore, the nearest town, are in Southland County as now constituted, Mokoia Farm is in the old provincial district of Otago. The name Gore, as used throughout this memoir, almost invariably refers to Mokoia Farm. Southland now means the present county of that name, together with the adjoining county of Wallace, or part of it, rather than the old provincial district of Southland.—[P. G. M.]

(2) McKay (1881). (3) McKay (1881), p. 42.

forms from the Jurassic of Australia. *Elatocladus conferta* and *Araucarites cutchensis* appear to occur both in the Rhætic and Jurassic in New Zealand, but on the latter horizon only in India. The occurrence of these genera and species thus inclines me provisionally to regard the flora of the Gore beds as Lower, rather than Middle, Jurassic.

Age.—Lower Jurassic.

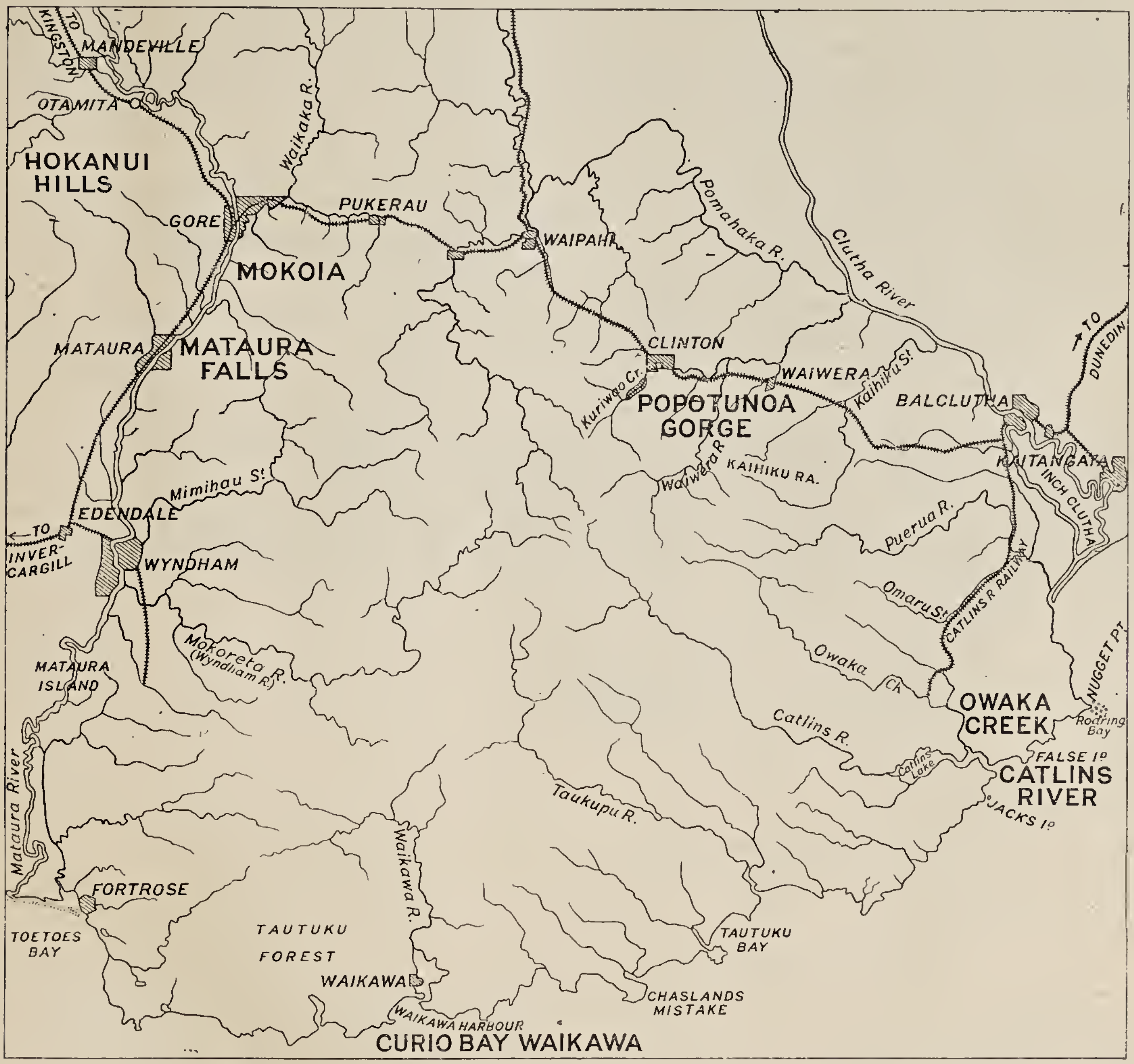

Fig. 5. Sketch-map of a Part of Southland and Otago, in South Island, showing the Fossil-plant Localities at Gore, Mataura Falls, Waikawa, Catlin's River, etc.

G. The Jurassic Flora of the Mataura Falls, Southland.

Locality.—The locality lies within the township of Mataura, on the important river of the same name, from the bed of which the specimens were collected. The Mataura plant-beds were described by McKay(1) in 1881, and by Park(2) in 1887. The best impressions come from the "tabular rocks between the main fall and the paper-mill on the eastern bank" of the Mataura. The beds consist of "alternations of a green, coarse-grained sandstone, and dark-coloured sandy beds of a more shaly character, the upper surface of these latter beds being often full of the rootlets of plants"(3).

The Collections.—The material described here belongs partly to the New Zealand Geological Survey collection and partly to a collection in the Geological Department

(1) McKay (1881).
(2) Park (1887).
(3) McKay (1881), p. 40.

of the British Museum (Natural History). The specimens appear to have all been collected either in 1863 by Buchanan, or by McKay in 1879. Mr. Lillie visited the locality in 1912, but was unable to obtain any further specimens.

Previous Records.—The occurrence of various species in this locality has been recorded by Hector, Ettingshausen, and Crié, as set forth in my previous note "On the Earlier Mesozoic Floras of New Zealand"(1). With one exception these lists consist entirely of *nomina nuda*, which need not detain us here. Full reference to these will be found in my previous paper. Hector(2), however, in 1886, figured six specimens from this locality (see also page 4), which were—

Hector's Names.		Names here adopted.
Macrotæniopteris lata O. & M. ..	=	*Tæniopteris crassinervis* (Feist.).
Lomarites pectenata Hect. ..	=	*Microphyllopteris pectinata* (Hect.).
Taxites manawao Hect. ..	=	*Pagiophyllum peregrinum* (L. & H.).
Pterophyllum matauriensis Hect.	=	*Ibid.*
Sphenopteris asplenoides Hect. ..	=	? (3).
Taxites kahikatea Hect. ..	=	?

Previous Opinion with regard to the Age of the Beds.—McKay(4) placed these beds in the Mataura Series of Upper Jurassic age.

Conclusions as to the Age of the Beds.—The fossil flora of Mataura Falls, though small, is a very interesting one. The following are the records described here:—

FERN-LIKE PLANTS—
- *Tæniopteris crassinervis* (Feistm.).
- *Dictyophyllum acutilobum* (Braun).
- *Microphyllopteris pectinata* (Hect.).
- *Cladophlebis denticulata* (Brongn.).
- *C. australis* (Morr.).

CYCADOPHYTA—
- *Nilssonia elegans* sp. nov.
- *Pterophyllum matauriensis* Hect.

CONIFERALES—
- *Pagiophyllum peregrinum* (L. & H.).

There can be little doubt, I think, that this flora is thoroughly Jurassic, and that it belongs either to the lower or to the middle division of that system. *Tæniopteris crassinervis* (Feistm.) is a very characteristic plant in the Mataura Falls beds. In India it occurs in the Middle Jurassic of the Rajmahal Hills. *Microphyllopteris pectinata* is also allied to another species occurring in the same beds in India. *Cladophlebis denticulata* is abundant in the Middle Jurassic of England, but no doubt has a somewhat extensive vertical range. The two Cycadophytes appear to be new and somewhat isolated species, and do not help as to the horizon. On the other hand, in *Pagiophyllum peregrinum* we have a distinctly early Jurassic type, occurring in the Lias of Britain. *Dictyophyllum acutilobum* is another Rhætic and early Jurassic type. On the whole, the occurrence of these fossils leads me to favour a Lower rather than a Middle Jurassic horizon.

I should be inclined to regard the Mataura Falls beds as slightly younger than those at Mokoia, Gore, though both very probably belong to the same division of the Jurassic. The two floras are very different, and there are therefore few grounds for

(1) Arber (1913^2).
(2) Hector (1886^1).
(3) I have not seen any examples of this plant. The specific name, however, cannot stand, for it had already been applied to another plant by Sternberg in 1826.
(4) McKay (1881), p. 42.

comparison; but on the whole I should imagine that the Mokoia beds belong to the lowest part of the Lower Jurassic, and the Mataura Falls beds to the higher part of the same. This conclusion, however, may well be only a matter of personal opinion.

Age.—Lower Jurassic.

H. The Jurassic Flora of Waikawa, Southland.

Locality.—The fossil plants of Waikawa come from Curio Bay, some little distance along the coast to the west of the mouth of the River Waikawa, Southland(1) (see map, fig. 5). The geology of the district has been described by Park(2).

The beds of Curio Bay, Waikawa, are of particular interest as affording an example of a petrified forest of Jurassic age, in addition to furnishing many well-preserved impressions of the ordinary type. The petrified forest is exposed by the action of the sea on the shore-line, in the neighbourhood of high-water mark (see figs. 6, 7). The known examples of such fossil forests of Mesozoic age are extremely few, and this is perhaps the most remarkable of all of them.

The forest is thus described by Park(3):—

"The sequence is as follows:—

"(1.) Coarse pebbly sandstone, in places passing into a conglomerate.

"(2.) Green sandstones, alternating with blue shaly clays with distinct plants.

"The most characteristic feature of the underlying beds (No. 2) is the large quantity of silicified timber which occurs in them. Many stumps ranging from 1 ft. to 6 ft. in height, and in some cases as much as 2 ft. in diameter at their base, are still standing in the places where they grew. On account of their more flinty and refractory nature they withstand the action of the sea much longer than the surrounding rocks; and it is not at all uncommon to see an erect trunk standing out in fine relief in the face of the steep sea-cliff, the massive root and smaller branching rootlets extending far into the underlying beds, and the trunk passing upward through various layers or beds of sandstones and shales. As already stated, the rocks here are lying almost flat, and at low water form wide shelving ledges, which are thickly strewn with the fallen or prostrate trunks and limbs of these silicified trees, many of which are over 50 ft. in length, while one was measured which exceeds 100 ft."

Mr. Lillie visited this petrified forest in November, 1912, and in a letter to me written a few weeks later he thus describes it:—

"At Curio Bay, Waikawa, there is a petrified Jurassic forest, showing the stumps of trees with their roots as they grew. The forest is undoubtedly *in situ.* The strata are very nearly horizontal, and the sea is exposing the bed which contains the forest, so that the rocky floor or strand of Curio Bay is the old forest-floor, with the stumps of trees standing up and the trunks of trees lying prostrate, just as if a Jurassic some one had been cutting timber! No trees, however, have been seen standing vertical and penetrating through several beds above, but both the fallen logs and the rooted stumps are contained within a single bed. The trunks vary from about 2 ft. in diameter to 1 in. or 2 in. Two hundred stems could easily be counted on the beach.

"Silicified wood has been obtained at intervals for some eight miles along the coast from Waikawa, and also inland near Waimahaka, so the area is a large one, and the forest is not confined to a few beds."

Figs. 6 and 7 show various parts of this fossil forest.

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(1) Waikawa, like Mokoia Farm, is in the present county of Southland, but in the old provincial district of Otago. See footnote (1) on page 12.—[P. G. M.]

(2) Park (1887).

(3) Park (1887), pp. 149–50.

From the structure of some fossil woods in the New Zealand Survey collection which are believed to have been derived from this locality it would appear that this fossil forest is composed chiefly of trees having the Araucarian type of structure. These woods are not described here, however, as the records of the locality from which they were obtained are uncertain. They appear, however, to be similar to *Araucarioxylon australe* Crié(1). There is also, I think, little or no doubt that the Osmundaceous stems described by Crié(2), and more recently by Kidston and Gwynne-Vaughan(3), which were recorded as having been obtained at Toitoi and at Gore were really derived from the neighbourhood of Curio Bay, Waikawa(4).

The Collections.—This locality is one of the richest in plant-remains known in New Zealand, so far as the Mesophytic floras are concerned. I have examined a large series of specimens, collected by Hector in 1878 and by Park in 1886, belonging to the New Zealand Geological Survey collection.

Previous Records.—With the exception of various *nomina nuda* mentioned by Hector(5) and others, the following are the only species hitherto figured from Waïkawa. They were published by Hector(6) in 1886:—

Hector's Name.		Modern Name.
Taxites manawao Hect. ..	=	*Elatocladus tenuifolia* (McCoy).
Pecopteris grandis Hect. ..	=	*Cladophlebis australis* (Morr.).
Asplenites palæopteris Unger ..	=	*Coniopteris hymenophylloides* (Brongn.).

Park(7) says that *Macrotæniopteris lata,* and *Tæniopteris stipulata,* as well as *Pecopteris, Asplenites, Taxites, Lomarites,* and *Camptopteris* also occur.

In 1907 Kidston and Gwynne-Vaughan(3) described the petrified stems of *Osmundites Dunlopi* K. & G.-V. and *O. Gibbiana* K. & G.-V., which, as mentioned above, were no doubt derived from this locality.

Conclusions as to the Age of the Beds.—The following is a list of the records from Waikawa:—

Fern-like Plants—
- *Osmundites Dunlopi* K. & G.-V.
- *O. Gibbiana* K. & G.-V.
- *Cladophlebis australis* (Morr.).
- *Coniopteris hymenophylloides* (Brongn.).
- *Thinnfeldia Feistmanteli* (Goth.).
- *Tæniopteris vittata* Brongn.

Cycadophyta—
- *Cycadites* sp.
- *Ptilophyllum acutifolium* Morr.
- *P.* sp.

Podozamiteæ—
- *Podozamites gracilis* sp. nov.

Coniferales—
- *Elatocladus conferta* (O. & M.).
- *E.* sp.

There can be no doubt, I imagine, that this flora is of Jurassic age, but the question as to the division of the Jurassic to which it should be assigned is of a more

(1) Compare Crié (1889), p. 11, pl. 7, figs. 6, 7; pl. 8, figs. 1–4.
(2) Crié (1889), p. 11, pl. 7, figs. 1–5. (See Kidston and Gwynne-Vaughan (1916), p. 479.)
(3) Kidston and Gwynne-Vaughan (1907).
(4) Since this paper was completed I have received from Professor Sinnott a copy of his paper published in the Annals of Botany, 1914, which contains a discussion on specimens of *Osmundites* from Waikawa, and also from Kawhia, North Island.
(5) See Arber (1913²).
(6) Hector (1886¹), fig. 30A, on p. 66.
(7) Park (1887), p. 150.

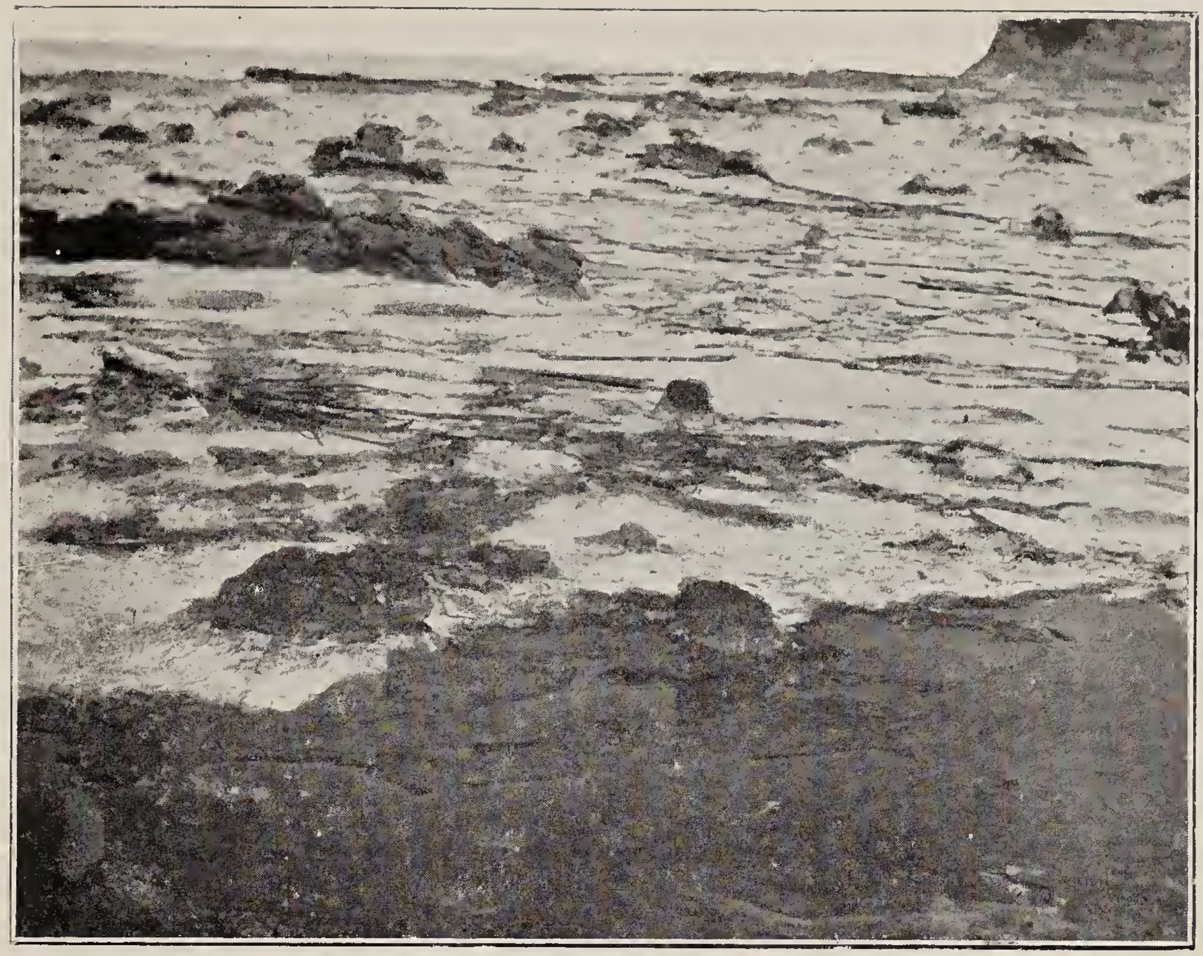

Fig. 6. The Fossil Forest of Waikawa, exposed on the Beach at Curio Bay, between Tidal Limits.

[*Dr. L. Cockayne, F.R.S., photo.*

Fig. 7. The Fossil Forest of Waikawa, exposed on the Beach at Curio Bay.

[*Dr L. Cockayne, F.R.S., photo.*

difficult nature. On the whole, I am inclined to think that it is a Middle Jurassic flora. In *Tæniopteris vittata* we have a plant which, in Britain, is commonly associated with *Coniopteris hymenophylloides* in the Middle Jurassic of Yorkshire. *Podozamites* is also found in beds of similar age in various parts of the world. In the Middle Jurassic floras of India *Ptilophyllum acutifolium* and *Elatocladus conferta* both occur.

On the other hand, in *Thinnfeldia Feistmanteli* we have a fossil which probably, or perhaps certainly, occurs in beds elsewhere of somewhat older age than the Middle Jurassic. It is, however, not necessary to assume that it is restricted to the older horizons. It may have had a wide range in Jurassic time.

Our knowledge of Upper Jurassic floras is at present very limited, and it is difficult to say exactly how far that flora differed from that of the Middle Jurassic. On the whole, I have little doubt that, on the present evidence, the Waikawa flora is best regarded as of Middle Jurassic age.

Age.—Middle Jurassic.

I. The Neocomian Flora of Waikato Heads, Auckland.

Locality.—The Waikato Heads lie on the south side of the estuary of the River Waikato, in Auckland (see map, fig. 8). The plant-bearing beds here have been described by Cox(1).

The Collections.—I have seen only two small but very interesting collections from this locality. Most of the specimens in these were gathered by Hector in 1866(2). One of these collections belongs to the New Zealand Geological Survey; the other has been in the British Museum for many years past. Some plants, however, had been collected from this locality at an earlier date by members of the Novara Expedition, but I have not seen this collection.

Previous Records.—Unger(3) in 1864 figured a single specimen from this locality under the name *Polypodium Hochstetteri* sp. nov. This I regard as *Cladophlebis australis* (Morr.).

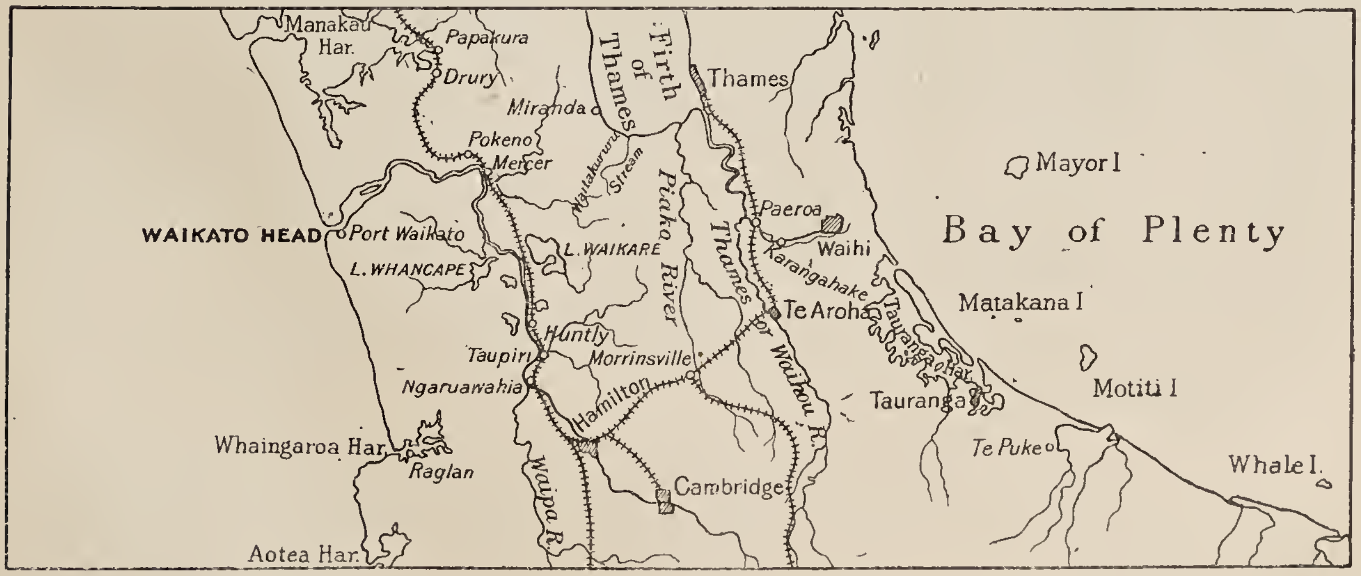

Fig. 8. Sketch-map of a Part of North Island, showing the Position of the Neocomian Plant-bearing Beds at Waikato Heads.

Previous Opinion as to the Age of the Beds.—A considerable number of formations are represented near the Waikato Heads(4). Unger(5) regarded the plant-beds as

(1) Cox (1877), p. 19.

(2) Cox (*ibid.* p. 19) stated in 1877 that he could find very few specimens, and did not think that he could add any fresh species to those already known.

(3) Unger (1864), p. 5, pl. ii, figs. 1, 2.

(4) Cox (1877), map opposite p. 16.

(5) Unger (1864), p. 5.

probably of Wealden age, and Lower Cretaceous animal-remains were also recorded by the Novara Expedition from the associated beds. On the other hand, Cox(1) apparently referred the plant-beds to the Jurassic, as part of the Mataura Series.

Conclusions as to the Age of the Beds.—The flora from Waikato Heads is a small one, consisting of the following species:—

FERN-LIKE PLANTS—
- *Tæniopteris arctica* Heer.
- *Cladophlebis australis* (Morr.).
- *C. Albertsi* ? (Dunk.).
- *C.* sp.
- *Microphyllopteris pectinata* (Hect.).
- Genus *Incertæ Sedis*—
  - *Nageiopsis longifolia* ? Font.

ANGIOSPERMÆ (DICOTYLEDONES)—
- *Artocarpidium Arberi* Laur.
- *Phyllites* sp.

There can be no doubt, I think, as to the Neocomian age of this flora. The presence of Angiospermous remains is in itself sufficient to show that these beds are younger than the Jurassic. On the other hand, the scarcity of the Angiospermous fossils and the prevalence of Mesophytic types indicate that in all probability the Waikato Heads flora is not more recent in age than the Lower Cretaceous.

This flora is particularly interesting as being perhaps one of the oldest, in a geological sense, of the known Neophytic floras. Angiosperms occur, but they are few and rare, and this group apparently was not dominant at this period in New Zealand. At any rate, at Waikato Heads it is the other types, all of which are Mesophytic, which are the dominant factors in the flora. Some of these, such as *Cladophlebis australis* and *Microphyllopteris pectinata*, occur also in the Jurassic of New Zealand. However, in the doubtful attributions to *Cladophlebis Albertsi* and *Nageiopsis longifolia*, we have fossils which are more characteristic of the Lower Cretaceous, and which are probably unknown from sediments of earlier age than the Wealden. *Tæniopteris arctica* is also a Cretaceous type. On the other hand, the absence of a large number of typically Wealden species, such as *Onychiopsis Mantelli*, which occurs in Europe and South Africa, is somewhat remarkable (see p. 25). I think, however, the presence of Angiospermous remains, in association with the Lower Cretaceous species above indicated, leaves no room for doubt that this scanty flora is of Lower Cretaceous age. It is to be particularly desired that further collections from this locality may be made before long, and that our knowledge of this very interesting early Cretaceous flora may be thereby extended.

Age.—Neocomian.

J. THE FOSSIL PLANTS OF WAIROA GORGE, WAIMEA COUNTY, NELSON.

Locality.—The beds of Wairoa Gorge, Waimea County, Nelson, were described by McKay(2) in 1878.

The Collection.—The New Zealand Geological Survey possesses a small collection from this locality, made by McKay.

Conclusions as to the Age of the Beds.—The specimens, with the single exception of the seed here figured under the name *Carpolithus McKayi*, are all too badly preserved for determination. Consequently nothing can be said as to the age of the beds, beyond the conclusion that they are no doubt Mesozoic.

Age.—Uncertain.

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(1) See Cox (1877), pp. 13, 18.

(2) McKay (1878³), pp. 119, 150.

CHAPTER IV.

DISTRIBUTION OF SPECIES IN NEW ZEALAND, WITH REMARKS ON THE AGE OF THE FLORAS.

The following table shows the distribution in New Zealand of all the species here described :—

List of the Mesozoic Species here recorded from New Zealand.

Species.	Mount Potts.	Clent Hills.	Hokonui Hills or Catlin's River.	Malvern Hills.	Mokoia, near Gore.	Mataura.	Waikawa.	Waikato Heads.
Equisetales.								
1. *Equisetites Nicoli* sp. nov.	..	..	..	..	x	..	..	..
2. *Phyllotheca minuta* sp. nov.	x	x	..	..	..	..	..	..
Fern-like Plants.								
3. *Chiropteris lacerata* Arber	x	..	..	..	..	..	..	..
4. *Cladophlebis* cf. *C. Albertsi* (Dunk.) ..	..	..	..	..	..	..	..	x
5. *C. australis* (Morr.)	x	x	x	x	..	x	x	x
6. *C. denticulata* (Brongn.)	..	..	..	x	..	x	..	..
7. *C.* sp.	..	..	..	..	..	..	..	x
8. *Coniopteris hymenophylloides* (Brongn.)	..	..	..	x	x	..	x	..
9. *Dictyophyllum acutilobum* (Braun) ..	x	x	..	..	..	x	..	..
10. *Dictyophyllum obtusilobum* (Braun) ..	..	..	..	..	?	..	..	..
11. *Linguifolium Lillieanum* Arber ..	x	..	..	x	..	..	..	..
12. *Microphyllopteris pectinata* (Hect.) ..	..	..	..	..	..	x	..	x
13. *M.* sp.	..	..	x	..	..	..	..	..
14. *Sphenopteris Currani* (T.-W.) ..	..	..	..	..	?	..	..	..
15. *Sphenopteris (Ruffordia) Gœpperti* Dunk.	..	..	..	..	x	..	..	..
16. *S. gorensis* sp. nov.	..	..	..	..	x	..	..	..
17. *S. otagoensis* sp. nov.	..	..	x	..	..	..	..	..
18. *S. owakaensis* sp. nov.	..	..	x	..	..	..	..	..
19. *S.* sp.	..	..	x	x	..	..	..	..
20. *Tæniopteris arctica* Heer	..	..	..	..	..	..	..	x
21. *T. crassinervis* (Feist.)	..	..	..	..	..	x	..	..
22. *T. Daintreei* McCoy	..	x	x	x	..	..	..	..
23. *T. Thomsoniana* sp. nov.	x	x	..	..	..	..	..	..
24. *T. vittata* Brongn.	..	..	..	..	..	..	x	..
25 *Thinnfeldia argentinica* (Gein.) ..	..	?	..	..	..	..	..	..
26. *T. Feistmanteli* (Goth.)	..	..	?	..	..	..	?	..
27. *T. lancifolia* (Morr.)	x	..	x	..	..	..	..	..
28 *T. odontopteroides* (Morr.)	..	x	x	..	..	..	..	..
29. *T.* sp.	..	..	..	..	x	..	..	..
Cycadophyta.								
30. *Cycadites* sp.	..	..	..	..	..	..	x	..
31. *Nilssonia compta* (Phill.)	..	..	..	..	?	..	..	..
32. *N. elegans* sp. nov.	..	..	..	..	..	x	..	..
33. *Pterophyllum matauriensis* Hect. ..	..	..	..	..	..	x	..	..
34. *Ptilophyllum acutifolium* Morr. ..	..	..	..	..	..	..	x	..
35. *P.* sp.	..	..	..	..	..	..	x	..

LIST OF THE MESOZOIC SPECIES HERE RECORDED FROM NEW ZEALAND—*continued.*

Species.	Mount Potts.	Clent Hills.	Hokonui Hills or Catlin's River.	Malvern Hills.	Mokoia, near Gore.	Mataura.	Waikawa.	Waikato Heads.
PODOZAMITEÆ.								
36. *Podozamites gracilis* sp. nov. ..	..	..	..	..	..	..	x	..
GINKGOALES.								
37. *Baiera robusta* sp. nov.	x	..	..	..	..	..	..	..
CONIFERALES.								
38. *Araucarites cutchensis* Feist. ..	?	..	..	..	x	..	..	..
39. *Brachyphyllum* sp.	..	..	x	..	..	..	..	..
40. *Cryptomerites* sp.	..	..	x	..	..	..	..	..
41. *Elatocladus conferta* (O. & M.) ..	x	x	..	x	x	..	x	..
42. *E.* sp.	..	..	..	..	..	..	x	..
43. *Nageiopsis longifolia* ? Font. ..	..	..	..	..	..	..	..	x
44. *Pagiophyllum peregrinum* (L. & H) ..	..	..	..	..	..	x	..	..
45. *Stachyotaxus* sp.	..	..	..	..	x	..	..	..
ANGIOSPERMÆ (DICOTYLEDONES).								
46. *Artocarpidium Arberi* Laur. ..	..	..	..	..	..	..	..	x
47. *Phyllites* sp.	..	..	..	..	..	..	..	x
INCERTÆ SEDIS.								
48. *Carpolithus McKayi* sp. nov. ..	..	..	..	..	..	..	..	..
Obscure fructifications	..	..	..	..	..	..	..	x
Roots	..	..	..	..	..	x	..	..

It will be seen from the above list that the number of figured records here described from New Zealand exceeds forty-eight(1), including thirty-seven species, as compared with eleven species, which were alone recorded at the commencement of this investigation(2). Of these, at least fourteen species are new or described here for the first time, and do not appear to be known from other parts of the world—a somewhat high percentage. Two new genera, *Linguifolium* and *Microphyllopteris*, are here instituted, members of which have been previously recorded from other countries. The remaining genera are both widely distributed, and among the commonest types constituting the Mesophytic floras of all regions.

The present investigation of the earlier fossil floras of New Zealand has shown that there is, at the time of writing, no evidence of any terrestrial vegetation older than the Triasso-Rhætic. It is a remarkable fact that, despite assertions to the contrary, no trace of any Palæozoic floras has been found in these islands. Even in Permo-Carboniferous times, when the southern continent of Gondwanaland included a very large part of the Southern Hemisphere, New Zealand did not, on the known evidence, form any part of that continent, as might perhaps have been anticipated. In fact, there is no evidence to show either that New Zealand was connected with Australia or Antarctica in late Palæozoic times, or even that New Zealand then existed at all.

(1) In addition to three valid records previously described, of which no specimens are here recorded. The total number of established records of New Zealand Mesophytic plants is consequently now fifty-one species.

(2) Arber (1913[2]), p. 129, and page 4 of this memoir.

At present it appears that these islands did not rise above sea-level until Mesozoic times. It may be, of course, that *Glossopteris*-bearing rocks really occur in New Zealand, and that they have so far been overlooked. It is always somewhat dangerous to rely on negative evidence. On the other hand, wherever *Glossopteris*-bearing sediments occur in the Southern Hemisphere, they appear to form sheets of considerable thickness, very widely spread and not localized. The geology of New Zealand is now well known. A Geological Survey has existed in these islands for more than half a century, and it is thus very unlikely that any well-developed series of sediments with a wide distribution has been overlooked. Unless the extent and distribution of these beds is here quite exceptional, this possible source of error may be dismissed with confidence.

It is not contended that no beds of Permo-Carboniferous age occur in New Zealand. All that is asserted is that these beds, if they exist, have not yielded *Glossopteris* or any member of the *Glossopteris* flora. Personally, I should not be surprised to hear that these plants had been at length discovered in New Zealand in Palæozoic rocks, though I think it is now unlikely that such a discovery will be made. So far, however, as the present evidence is concerned, the point is that, while marine sediments of Permo-Carboniferous age may be expected to occur, there is no trace of any beds containing relics of the terrestrial flora of that period. If New Zealand did not exist as dry land at that time, marine sediments would naturally be laid down over the area, and these would be elevated at a later period when it became converted into dry land. These, however, may be very unfossiliferous. On the other hand, it seems impossible to suppose that estuarine, littoral, or fresh-water deposits occur, similar to those formed at the same period in Australia and elsewhere, but containing no traces of the terrestrial life of the period, whereas such relics are extraordinarily abundant in the corresponding rocks throughout Gondwanaland. I feel confident that if such rocks occur they will eventually yield *Glossopteris*, or some other characteristic member of that flora, and not prove to be entirely barren. However, as the matter stands at present, the history of New Zealand as a land area cannot be carried back beyond the early Mesozoic period.

In a recent paper by Professor Seward, some remarks will be found on my conclusion that there is no evidence that New Zealand ever formed part of Gondwanaland. This, on Seward's view, is "open to question." He is inclined to see in *Linguifolium* a plant, "if not generically identical with, at least very closely related to *Glossopteris*." He further adds, "there is, moreover, a very close resemblance between several New Zealand species and plants from the Rhætic floras of Tonkin, South Africa, and elsewhere, which contain representatives of *Glossopteris* or other members of the later floras of the Gondwana continent." At the same time he admits that the Mount Potts flora is "no doubt Upper Triassic or Rhætic"(1).

With the comparison between *Linguifolium* and *Glossopteris* I have dealt elsewhere (pp. 35–38), giving my reasons for rejecting this view. I merely wish to remark here that I use the term "Gondwanaland" in the usually accepted sense of the *Permo-Carboniferous* continent; and since neither Seward nor any one else has produced an *Upper Palæozoic flora* as yet from New Zealand, I conclude that New Zealand formed no part of that continent. I know of no application of the name "Gondwanaland" to a Mesozoic land area; in fact, the usefulness of this term would disappear entirely were it so used. The well-known fact that many of the genera of the *Glossopteris* flora survived in Mesozoic times, in many widely separated areas, is beside the point. Directly we reach the Mesozoic period we meet everywhere with a new flora; and whether it does or does not contain genera common to the *Glossopteris* flora, it

(1) Seward (1914), p. 39.

cannot by any stretch of terminology be termed a *Glossopteris* flora, nor can the region in which it flourished be termed Gondwanaland. *Phyllotheca*, for instance, which is an important Permo-Carboniferous genus in Gondwanaland, occurs in the Rhætic in New Zealand and elsewhere, and, on Professor Seward's own showing, as late as the Lower Cretaceous in South Africa. Yet these Mesozoic floras, in which *Phyllotheca* occurs, are not the *Glossopteris* flora, nor did they flourish on a Permo-Carboniferous continent, Gondwanaland.

On the other hand, in New Zealand we have a fairly complete series of Mesophytic floras, ranging from the Triasso-Rhætic to the Neocomian. In the provinces of Canterbury and Otago, Rhætic floras occur. Jurassic floras are met with in the provinces of Canterbury and, especially, Southland. A Neocomian flora occurs in Auckland, but no evidence of an undoubted Upper Jurassic flora has been met with so far.

Any one who is familiar with the large literature on the stratigraphical geology of New Zealand, is aware of the many contradictory and confused systems of primary classification, which have been proposed, at one time or another, for the sedimentary rocks of these islands, particularly by Hector and Hutton. Between 1878 and 1903 no less than four such schemes(1) were propounded for the Mesozoic rocks alone. Even in the most recent text-books(2) on the geology of New Zealand two quite different systems of classification of the sedimentary beds are proposed. Further, rocks which are no doubt Triasso-Rhætic in age have been called Silurian, Devonian, or even Archæan! Others of similar age have been erroneously referred to the Upper Palæozoic. Consequently, confusion worse confounded has resulted; and if this has been the case within New Zealand itself, it will be readily understood how difficult it has been in Europe to arrive at any satisfactory conclusions as to the geological age of the more important sediments of the Dominion. New Zealand, until quite recently, appears to have always lacked a competent palæontologist, trained in Europe. The palæontological side seems to have been as weak as specialism in physical geology has been strong, and consequently long-continued uncertainty has existed as to the real nature of the fossil evidence.

I do not propose to enter here into the controversies as to the age of the beds or their floras; such would serve no useful purpose. I hope, however, that the present contribution, which will no doubt prove to be only an initial step to the knowledge of the future, will do something to set at rest the doubts as to the age of the beds with which I am concerned here.

(1) Hector (1879^3), (1880), (1881^2); Cox (1878); Hutton (1885); Park (1904).

(2) *Cf.* Park (1910), p. 25; Marshall (1912), pp. 173, 208.

CHAPTER V.

A COMPARISON OF THE EARLIER MESOZOIC FLORAS OF NEW ZEALAND WITH THOSE OCCURRING ELSEWHERE.

I PASS now to a comparison of the earlier Mesozoic floras of New Zealand with those occurring in Mesozoic rocks in the Southern Hemisphere and elsewhere.

Commencing with the Rhætic floras of Mount Potts, the Clent Hills, and perhaps the Catlin's River, we have to deal with a vegetation which does not appear to be, as a whole, specifically identical with that of the same age occurring in Australia, South Africa, and in various localities in the Northern Hemisphere. The commonest plant in the Rhætic of New Zealand, as in the Jurassic and perhaps also the Lower Cretaceous, is that great weed of Mesozoic times, if I may so term it, *Cladophlebis australis* (Morr.). This species occurs in vast abundance in the Mesozoic rocks throughout the Southern Hemisphere, and seems, like the Bracken-fern of to-day, to have flourished in many widely separated areas with the greatest vigour and success. Next in frequency among the ferns we have several species of *Thinnfeldia* The genus is very abundant in the earlier Mesozoic rocks of Australia and Tasmania, and also occurs in beds of the same age elsewhere. In the possible occurrence of *Thinnfeldia argentinica* (Gein.) we have a South American Rhætic fossil.

Of the Coniferous remains, the widely spread species *Elatocladus conferta* (O. & M.) occurs abundantly in New Zealand in both the Rhætic and Jurassic. The distribution of this plant at the latter period extended from India to Antarctica(1). Of the rarer types, *Phyllotheca minuta* sp. nov. appears to be new, though the same genus occurred in Australia, South Africa, and even in Europe in Rhætic times. *Linguifolium* (which in New Zealand is both Rhætic and Lower Jurassic) is represented in the Mesozoic rocks of Australia, and *Chiropteris* in the Rhætic of South Africa and in Mesozoic beds in South America and Australia, but apparently in both cases by species distinct from those found in New Zealand. *Dictyophyllum acutilobum* (Braun) is widely spread in the Rhætic of Europe.

Representatives of the Ginkgoales appear to be rare in New Zealand. *Baiera robusta*, a new species, but very similar to certain Rhætic Baieras occurring in Europe, is the sole record of this group from New Zealand.

In *Tæniopteris Daintreei* we have a species more abundant in the Jurassic than the Rhætic.

The Mesophytic flora of New Zealand affords another illustration of the similarity of the Rhætic to the Lower Jurassic flora. Nearly all the genera and many of the species occurring in New Zealand are common to the two horizons. Some genera, among others *Microphyllopteris*, *Coniopteris*, *Osmundites*, and most of the representatives of the Cycadophyta and Coniferales, found in New Zealand appear to be unknown from the Rhætic.

The Jurassic flora includes *Equisetites Nicoli* sp. nov., closely allied to other species of the same genus, occurring in the Jurassic rocks of England, Scotland, and Siberia. *Cladophlebis denticulata* (Brongn.), as well as *C. australis* (Morr.), occurs. The former is also common in England and in other parts of the world, including Antarctica. *Linguifolium* occurs in the Jurassic as well as the Rhætic, and the same is true of *Dictyophyllum acutilobum* (Braun) and various species of *Thinnfeldia*. *Thinnfeldia Feistmanteli* (Goth.), however, appears to be a Jurassic rather than a Rhætic species. In *Tæniopteris crassinervis* (Feist.) and *T. vittata* Brongn. we have two thoroughly Jurassic

(1) Halle (1913[1]).

types, the former occurring in India and Australia, the latter in England and elsewhere in Europe. *Coniopteris hymenophylloides* Brongn., and *Nilssonia compta* (Phill.), are other widely distributed fossils in Jurassic sediments in various parts of the world. *Sphenopteris (Ruffordia) Gœpperti* Dunk. is more essentially a Wealden plant, though it is also known from Jurassic rocks in Europe and Antarctica.

Among the Cycadophytes, *Ptilophyllum acutifolium* occurs in the Jurassic of India and Antarctica. The genus *Podozamites,* of uncertain affinities, is represented by a new species in New Zealand.

Turning to the Coniferæ, we have *Elatocladus conferta* (O. & M.) and *Araucarites cutchensis* Feistm. occurring in Jurassic rocks in India and Grahamland. *Pagiophyllum peregrinum* (L. & H.) is a fossil first made known from the Lower Jurassic of Britain.

The Jurassic flora of New Zealand, as a whole, offers another illustration of the world-wide distribution of the plants of this period.

The following species here recorded from New Zealand are also British :

Cladophlebis denticulata (Brongn.).
Tæniopteris vittata Brongn.
Coniopteris hymenophylloides (Brongn.).
Sphenopteris (Ruffordia) Gœpperti Dunk.
Nilssonia compta (Phill.).
Pagiophyllum peregrinum (L. & H.).

Of extra-European Jurassic floras, the closest analogy is perhaps to that of the Upper Gondwanas of India, in which the following New Zealand plants also occur :—

Tæniopteris crassinervis (Feist.).
T. Daintreei McCoy.
T. vittata Brongn.
Ptilophyllum acutifolium Morr.
Elatocladus conferta (O. & M.).
Araucarites cutchensis Feist.

Among the floras of the Southern Hemisphere, the comparison with the Australian and Tasmanian Jurassic plants is more remote than might be anticipated, but this may be partly due to the fact that these southern floras are still very imperfectly known. The following species, however, are common to New Zealand and Australia :—

Cladophlebis australis (Morr.).
Thinnfeldia odontopteroides (Morr.).
T. lancifolia (Morr.).
T. Feistmanteli (Goth.).
Tæniopteris crassinervis (Feist.).
T. Daintreei McCoy.
Coniopteris hymenophylloides (Brongn.).
Sphenopteris Currani (T.-W.).
Elatocladus conferta (O. & M.).

No Jurassic plants are known from South Africa, and those recorded from South America are too few to form the basis of any comparison with the New Zealand flora.

The Jurassic flora of Grahamland(1), though as a whole specifically distinct from that of New Zealand, has, however, a certain number of types in common, particularly—

Cladophlebis denticulata (Brongn.).
Sphenopteris (Ruffordia) Gœpperti Dunk.
Coniopteris hymenophylloides (Brongn.).
Elatocladus conferta (O. & M.).
Araucarites cutchensis Feist.

(1) Halle (1913[1]).

The scanty flora of the Neocomian rocks of New Zealand naturally offers little material for comparison. Some of the plants appear to be similar to those found elsewhere in Jurassic rocks, such as *Cladophlebis australis* and *Microphyllopteris pectinata*, while others, such as *Cladophlebis Albertsi* (?), *Nageiopsis longifolia* (?) (both doubtful determinations), with *Tæniopteris arctica*, appear to be essentially Cretaceous plants occurring in England, America, and Spitzbergen respectively. The real interest in this flora lies in the comparative poverty of Angiosperms as compared with members of the truly Mesophytic genera. No doubt it is one of the earliest Angiospermous floras yet discovered.

The Neocomian flora of the Waikato Heads is also remarkable for the absence of many characteristic Wealden species, such as—

Onychiopsis Mantelli (Brongn.),
Weichselia Mantelli (Brongn.),
Otozamites Klipsteini (Dunk.),
Zamiophyllum Buchianum (Ett.),
Nilssonia Schaumburgensis (Dunk.),

some of which occur in the Uitenhage Series(1) of South Africa, a flora which, however, is somewhat unlike that occurring at Waikato Heads.

Among the broader conclusions we may, I think, hold that in Rhætic and probably also in Jurassic times New Zealand and Tasmania were united with Australia as one large connected land area. The floras of these now separated regions are nearly allied, but not identical, yet the similarity between them is probably sufficiently close to allow of this hypothesis. If this is the case the distribution of land in this quarter of the globe differed somewhat from that in Upper Palæozoic times, when, as we have seen, New Zealand formed no part of Gondwanaland.

As regards Antarctica, we have no evidence as yet of any Rhætic flora there, but in Jurassic times Grahamland may have been connected with New Zealand and also with Australia. It has been pointed out here that the floras of these three regions are similar, though as a whole perhaps specifically distinct. On the other hand, there does not appear to be similar evidence that South Africa was then united either to Antarctica or to Australia, for no trace of a land vegetation of Jurassic age is known from the former continent. Rhætic floras occur in South Africa, and are of a somewhat similar type to those of Australia. Thus the continental conditions of Permo-Carboniferous times may have been maintained as late as the Rhætic, but there is no evidence that in the direction of South Africa they were prolonged into the Jurassic period.

On the whole, so far as the present evidence leads us to any conclusions, the Mesozoic land-connections between Antarctica and the temperate regions of the Southern Hemisphere appear to have been chiefly in the direction of New Zealand and Australia. As regards South America the evidence at present is less certain. Wealden floras occur in Patagonia(2) and Peru(3), as in New Zealand and South Africa(4), but the plants so far recorded from these countries are somewhat dissimilar, and our knowledge of these floras is not sufficiently extensive to permit us to form any estimate as to how far these areas may or may not have been continuous or connected in Wealden times. From the Antarctic continent, so far as the Mesophytic floras are concerned, we have as yet no data relating to terrestrial plant-life, except in Jurassic times.

(1) Seward (1903, 1907).
(2) Halle (1913²).
(3) Zeiller (1914).
(4) So far as I am aware we have at present no clear evidence of a Neocomian flora from Australia.

CHAPTER VI.

SYSTEMATIC DESCRIPTIONS OF THE FOSSIL PLANTS.

Phylum EQUISETALES.

Genus EQUISETITES Sternberg, 1833.

(*Vers. Darstell. Flora Vorwelt*, Heft vii, p. 43.)

Equisetites Nicoli sp. nov. Plate III, fig. 2.

Diagnosis.—Stems fairly slender, 1 cm. or more across. Internodes smooth, 3 cm. or more in length. Leaves, between 15 and 20 in a whorl, united below for a short distance into a sheath closely clasping the stem, the upper portions free, very slender and acuminate, exceeding 2 cm. in length. Nodal diaphragms, 5–7 mm. in diameter.

Description of the Specimens.—Fragments of two leafless stems, both showing displaced nodal diaphragms, are figured, natural size, on Plate III, fig. 2. The more complete of these measures about 3·5 cm. in length and about 1 cm. in breadth. The nodal diaphragms have a diameter of 5–6 mm. The external surface of the stem appears to be smooth, or only faintly and discontinuously grooved. On the back of the same specimen other fragments of similar stems and of leaf-whorls occur, and in some cases parts of the leaf-sheath are probably in continuity with the stems.

Remarks.—The nodal discs of the New Zealand plant very closely resemble those of *Equisetites broraensis* Stopes(1), from the Jurassic of Scotland, an imperfectly known type, of which neither the stems nor the leaves have as yet been described. It would therefore be unwise for the present to refer the Gore specimen to the British species.

Equisetites Nicoli also approaches *E. lateralis* (Phil.), from the Lower Oolite of Yorkshire and Italy. They may even be identical, though at present I should be inclined to regard them as specifically distinct. There is still much mystery attaching to the Yorkshire species. Professor Seward(2) at one time regarded it as distinct from *Equisetites columnaris*, though latterly(3) he has united it with that species. I think it is quite certain that the New Zealand plant is not identical with *E. columnaris* (Brongn.). There are, however, several points of agreement with *E. lateralis*. The displaced nodal diaphragms, seen on Plate III, fig. 2, are similar to those of *E. lateralis*, though probably not identical. There are fewer "spokes in the wheel" in the New Zealand fossil.

The Rhætic *Equisetites Münsteri* Sternb., though showing some features in common, is far removed from the new Zealand fossil. The very fragmentary Australian specimen, termed by Tenison-Woods(4) *Equisetum rotiferum*, I regard as undeterminable specifically, but it shows displaced nodal diaphragms not unlike those of *Equisetites Nicoli.*

There has previously been some difference of opinion as to which genus—*Equisetites, Phyllotheca*, or even *Schizoneura*—such fossils should be referred to, but in this case there can be no doubt that the correct genus is *Equisetites.* In this genus the leaves are united at the base into a sheath, *closely appressed* to the stem, as in this fossil. In *Phyllotheca* there is also a basal sheath, but it is a loose, sac-like, spreading structure, not clasping the stem.

(1) Stopes (1907), p. 378, pl. xxvii, fig. 2.
(2) Seward (1898), vol. i, p. 275, text-figs. 63, 64.
(3) Seward (1900), vol. i, p. 56, text-figs. 3, 4.
(4) Tenison-Woods (1883), p. 66, pl. vi, figs. 5, 6.

The Jurassic plants of Siberia, described by Heer(1) as *Phyllotheca sibirica* Heer, are in my opinion members of the genus *Equisetites*, approaching somewhat closely the New Zealand fossils here under discussion. In both cases the free portions of the leaves are very elongate and acuminate, though the leaves as a whole do not appear to be precisely similar in form, and therefore the two plants are probably specifically distinct.

Type.—Sedgwick Museum, Cambridge.

Occurrence.—Mokoia, Gore, Southland (? Lower Jurassic).

Genus PHYLLOTHECA Brongniart, 1828.

(*Prodr. Hist. Veget. Foss.*, pp. 151, 175.)

Phyllotheca minuta sp. nov. Plate II, figs. 5, 9.

Diagnosis.—Detached whorls of leaves, cup-like in form. Leaves fleshy below, only united at the base, about 10 in a whorl, bases broad, leaves exceeding 5 mm. in length, lanceolate, tapering towards the apex, uninerved.

Descriptions of the Specimens.—In the New Zealand Survey collection from the Clent Hills a few detached leaf-sheaths occur, two of which are seen in Plate II, figs. 5 and 9, both natural size. That shown by fig. 9 was originally figured, but not described, by Hector(2). The sheath is here seen from below. The free portions of the leaves are shortly lanceolate, and about 3 mm. in length. There appear to be from seven to eight thick fleshy leaves in the whorl. A similar sheath, in which the leaves are less perfect, is shown on fig. 5 of the same plate.

Remarks.—There is little doubt, I think, that these specimens represent the foliage of a *Phyllotheca*, which, in the size of the sheaths and other characters, is unlike any species of that genus known to me. I therefore regard it as a new type, which I term *P. minuta* sp. nov. It occurs in the collections both from Mount Potts and the Clent Hills. In the former locality a variety of leafless stems, probably pith-casts of more than one type, have been found, and these also probably belong to the same genus.

Types in the New Zealand Geological Survey collection.

Occurrence.—Mount Potts (Rhætic); Clent Hills (Rhætic).

FERN-LIKE PLANTS.

Genus CHIROPTERIS Bronn, 1858(3).

(*Jahrb. für Mineral.*, Jahr. 1858, p. 143.)

Chiropteris lacerata Arber. Plate III, fig. 8.

1913. *Chiropteris lacerata* Arber, *Proc. Roy. Soc. London*, Ser. B, vol. lxxxvi, p. 346, pl. 8, fig. 6.

Diagnosis.—Leaf cuneate, exceeding 5 cm. in length and 3 cm. in breadth; apex deeply toothed, teeth fairly broad; veins fine, close, frequently anastomosing.

Description of the Specimen.—This plant appears to be rare at Mount Potts. The type specimen, which is itself imperfect, is seen enlarged on Plate III, fig. 8. It is nearly 6 cm. long. It is not quite certain that the termination of this leaf is the true apex, neither is it beyond doubt that the apparent teeth were a natural feature—they may be due to the imperfect preservation of the apical region; but, so far as one can judge from a single specimen, I think it more likely that the apex of the leaf was in nature deeply incised.

(1) Heer (1876^2), p. 43, pl. iv, figs. 1–7; see also (1878), p. 4, pl. i, figs. 9–15; (1880), p. 9, pl. i, figs. 5, 6.

(2) Hector (1886^1), p. 65, fig. 30 (4) pars.

(3) Kurr, MS. name.

Remarks.—The genus *Chiropteris* is a somewhat rare type, only known at present from Rhætic rocks in various parts of the world. *C. digitata* Bronn(1), a much larger leaf, occurs in Europe, *C. cuneata* Carr.(2) in Australia and South Africa(3), *C. copiapensis* Solms(4) in South America, and *C. Zeilleri* Seward(5) in South Africa.

The specimen from South Australia described under the name *Anthrophyopsis* (?) sp. by Etheridge(6) in 1895 is also a member of this genus, and may be distinguished as *Chiropteris Etheridgei* sp. nov.

Type in the British Museum (Natural History).

Occurrence.—Mount Potts (Rhætic).

Genus CLADOPHLEBIS Brongniart, 1849.

(*Tabl. Genr. Veget. Foss.*, p. 25).

1. Cladophlebis *cf.* C. Albertsi (Dunker). Plate IV, figs. 2, 3.

1846. *Neuropteris Albertsii* Dunker, *Monogr. Norddeutsch. Wealdenbild.*, p. 8, pl. vii, figs. 6, 6*a*.
1870. *Pecopteris Whitbiensis* Trautschold, *Nouv. Mém. Soc. Nat. Moscou*, vol. xiii, (3) p. 215, pl. xix, fig. 2.
1871. *Alethopteris Albertsii* Schenk, *Palæontogr.*, vol. xix, p. 218, pl. xxvii, fig. 4.
1882. *Pteris ? Albertsi* Heer, Foss. Flora Grönlands (*Flor. Foss. Arctica*, Bd. vi, Abth. ii), p. 29, pl. xvi, figs. 5, 6; pl. xxviii, figs. 1–3; pl. xlvi, figs. 22–24.
1888. *Pteris Albertini* Velenovsky, *Abhandl. k. böhm. Gesell. Wissen. (Math.-Nat. Cl)*, Ser. 7, Bd. ii, No. 8, p. 15, pl. iv, figs. 6–8.
1889. *Cladophlebis inclinata* Fontaine, *Monogr. U.S. Geol. Surv., xv*, p. 76, pl. x, figs. 3, 4; pl. xx, fig. 8.
1889. *Cladophlebis denticulata* Fontaine, *ibid.*, p. 71, pl. iv, fig. 2; pl. vii, fig. 7.
1889. *? Cladophlebis pachyphylla* Fontaine, *ibid.*, p. 80, pl. xxv, fig. 9.
1889. *? Aspidium angustipinnatum* Fontaine, *ibid.*, p. 98, pl. xvi, figs. 1, 3, 8; pl. xvii, figs. 1, 1*a*; pl. xix, fig. 10.
1894. *Cladophlebis Albertsii* Seward, *Wealden Flora*, pt. i, p. 91, pl. viii.
1905. *? Dryopteris angustipinnata* Ward, *Monogr. xlviii, U.S. Geol. Surv.*, p. 540 &c., pl. cxiv, fig. 6.
1911. *Cladophlebis Albertsii* Berry, *Maryland Geol. Surv. Lower Cretac.*, p. 252, pl. xxxii, figs. 3, 4.

Diagnosis.—The following diagnosis was given by Seward in 1894 (see above): "Frond bipinnate, rachis flat and broad, pinnæ linear-lanceolate, alternate to opposite, pinnules falcate, contiguous, attached by the whole of the broad base, acuminate, margin entire or slightly dentate towards the apex."

Description of the Specimens.—Two examples of fronds from Waikato Heads, with small, triangular, somewhat falcate pinnules, are shown in Plate IV, figs. 2 and 3, natural size. In the larger, fig. 2, several pinnæ are seen attached to a slender axis. These vary from 1 cm. to 4 cm. in length, and the pinnules are about 7 mm. long. The nervation is obscure, but appears to be of the *Cladophlebis* type.

Remarks.—It may be doubted whether these specimens are sufficiently perfect to allow of specific determination. They appear to lie nearest to *Cladophlebis Albertsi* (Dunk.), to which perhaps they may be doubtfully referred.

Occurrence.—Waikato Heads, Auckland (Neocomian).

(1) Bronn (1858), p. 143, pl. xii, Schenk (1864), p. 86, pl. ii, fig. 4; Schimper (1869), vol. i, p. 643, pl. xliii; Schoenlein and Schenk (1865), p. 16, pl. xi, fig. 1*a*, 1*b*; Nathorst (1878²), p. 86, pl. xx, fig. 1.

(2) Carruthers (1872), p. 355, pl. xxvii, fig. 5.

(3) Seward (1903), p. 62, pl. ix, fig. 4.

(4) Solms (1899), p. 602, pl. xiii, figs. 1–4.

(5) Seward (1903), p. 63, text-fig. 7.

(6) Etheridge (1895), p. 141, pl. iv, figs. 2.

2. Cladophlebis australis (Morris). Plate IV, figs. 1, 5, ? 7, 8; Plate XIV.

1845. *Pecopteris australis* Morris, in Strzelecki, *Phys. Descr. N.S. Wales*, p. 248, pl. vii, figs. 1 2.
1863. *Pecopteris (Alethopteris) indica* Oldham and Morris, *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. i, pt. 1, p. 47, pl. xxvii.
1863. *Pecopteris (Asplenites) macrocarpa* Oldham and Morris, *ibid.*, p. 51, pl. xxviii, figs. 2, 3, 3*a*; pl. xxxvi, figs. 5–7.
1864. *Polypodium Hochstetteri* Unger, *Novara-Exped., Geol. Theil.* vol. i, pt. ii, Palæont., p. 5, pl. ii, figs. 1, 2.
1869. *Alethopteris australis* Schimper, *Traité Pal. Végét.*, vol. i, p. 569.
1875. *Pecopteris australis* McCoy, *Prodr. Pal. Victoria*, Dec. 2, p. 16, pl. xiv, fig. 3.
1877. *Alethopteris indica* Feistmantel, *Foss. Flora Gondw. Syst.*, vol. i, pt. ii, pp. 37–89; pl. xxxvi, figs. 4, 4*a*; pl. xlvi, figs. 3, 4.
1877. *Asplenites macrocarpus* Feistmantel, *ibid.*, pp. 39–91, pl. xxxvi, figs. 5–7; pl. xxxvii, figs. 3, 4; pl. xlviii, fig. 2.
1877. *Pecopteris (Asplenites) macrocarpa* Feistmantel, *ibid.*, vol. i, pt. iii, pp. 9–171, pl. i, figs. 1, 2.
1877. *Alethopteris (Cladophlebis) indica* Feistmantel, *ibid.*, vol. i, pt. iii, pp. 7–169, pl. i, figs. 3–5.
1878. *Alethopteris australis* Feistmantel, *Palæontogr.*, Suppl. 3, Lief. 3, p. 109, pl. xiv; figs. 1, 1*a*.
1883. *Alethopteris australis* Tenison-Woods, *Proc. Linn. Soc. N.S. Wales*, vol. viii, p. 111.
1883. *Alethopteris concinna* Tenison-Woods, *ibid.*, p. 112, pl. ix; fig. 1.
1883. *Todea australis* Renault, *Cour. Bot. Foss.*, vol. iii, p. 81, pl. xi.
1885. *Alethopteris australis* Curran, *Proc. Linn. Soc. N.S. Wales*, vol. ix, p. 251.
1886. *Pecopteris acuta* Hector, *Det. Cat. & Guide, N. Zeal. Court, Ind. & Col. Exhib.*, p. 65, fig. 30(2).
1886. *Pecopteris linearis* Hector, *ibid.*, p. 65, fig. 30(3).
1886. *Pecopteris ovata* Hector, *ibid.*, p. 65, fig. 30(6).
1886. *Pecopteris obtusata* Hector, *ibid.*, p. 66, fig. 30*a*(1).
1886. *Pecopteris grandis* Hector, *ibid.*, p. 66, fig. 30*a*(3).
1886. *Alethopteris australis* Johnston, *Geol. Tasmania*, pl. xxv, p. 153, figs. 5, 6, 8.
1888. ? *Alethopteris serratifolia* Johnston, *ibid.*, pl. xxiii, fig. 1.
1890 *Alethopteris australis* Feistmantel, *Mem. Geol. Surv. N.S. Wales*, Pal. No. 3, p. 109, pl. xxvii, figs. 3, 3*a*.
1892 *Alethopteris australis* Etheridge, in Jack and Etheridge, *Geol. and Pal. Queensland*, p. 370, pl. 16, fig. 1.
1900. *Alethopteris australis* McCoy, in Stirling, *Rep. Victorian Coalfields No. 7* p. 3, pl. ii, figs. 3, 3*a*.
1902. *Todea australis* Shirley, *Bull. 18, Geol. Surv. Queensland*, p. 10.
1904. *Cladophlebis denticulata* var. *australis*, Seward, *Rec. Geol. Surv. Victoria*, vol. i, pt. iii, p. 171 pl. xvi, figs. 25–27.

Diagnosis.—Frond bipinnate. Pinnæ oblique. Pinnules very variable in size and shape, lanceolate, straight or falcate; margin entire, not toothed; pinnules attached by the whole base to the rachis; apex acute or obtuse. Midrib well defined; lateral nerves of the characteristic *Cladophlebis* tuning-fork type, once dichotomized, or one or both branches of the primary dichotomy forking a second time. Fertile pinnæ similar to the sterile in form. Sori (?) oblique, linear, parallel to the lateral nerves.

Description of the Specimens.—On Plate XIV two pinnæ of this plant are seen, in which the pinnules and their nervation are particularly clear. A still more complete pinna is figured on Plate IV, fig. 1. The apical portion of a pinna seen on Plate IV, fig. 8, also probably belongs to this species. The above specimens are all from the Neocomian rocks of Waikato Heads, Auckland, and they appear to be indistinguishable from other examples from the Rhætic and Jurassic formations of New Zealand, such as that from the (?) Rhætic of Owaka Creek, Catlin's River, Otago, shown on fig. 5 of the same plate.

Remarks.—As is well known, this species, which in the Southern Hemisphere has a very wide vertical range, is an exceedingly difficult fossil to deal with, on account of the stereotyped nature of the frond. Were the fertile fronds known, one would expect to find that the sterile foliage of several different plants has been commonly included under the term *Cladophlebis australis* (Morr.). Yet, in dealing with the sterile foliage it appears to be quite impossible at present to recognize more than one type by any definite characters, apart from mere size. This type, *Cladophlebis australis,* is just as stereotyped as the coal-measure *Stigmaria ficoides* Sternb. The pinnules may be small or relatively large, narrow in proportion to their length, or comparatively broad, falcate or almost straight, pointed or obtuse. The nerves may fork twice, as in the type specimen, or only once; or in some pinnules one fork of the primary dichotomy of the lateral nerve may remain simple, while the other divides again. There is also every type of transition between the forms of lateral nervation above indicated. It seems to be quite impossible to recognize species founded simply on such variations. Further, as regards size, larger and smaller, longer and shorter pinnules may be expected to, and no doubt did, occur in different parts of the same leaf. Thus *Cladophlebis australis* is a very unsatisfactory, though at the same time an important and characteristic, fossil.

Further, *C. australis* appears to differ only from the British and European type, *C. denticulata* (Brongn.), in the absence of the denticulate margins characteristic of the latter species. It may well be doubted whether this character alone is of sufficient importance to warrant specific separation, especially as both species occur in the Mesophytic floras of the Southern Hemisphere, though the former is there more abundant than the latter. Professor Seward(1) has, in fact, regarded *C. australis* as a mere variety of *C. denticulata.* I am inclined, however, to keep the two species separate, at least provisionally. In cases where variations of any sort are so rare it would seem advisable to attribute some importance to a perfectly definite character, such as the presence or absence of a denticulate margin. But I am still more impressed by the fact that among the southern fossils which I have examined *C. australis* is everywhere by far the dominant type, *C. denticulata,* although occurring, being very much rarer. It therefore does not seem that the two fronds were obviously borne by the same plant. I am thus in agreement with the conclusions recently arrived at by Halle(2) in regard to the Grahamland fossils.

The specimens of *C. australis* previously figured by Hector (see synonymy) are for the most part fragments of apical portions of what were probably young fronds. They differ only in size from the larger leaves, and it appears to me to be quite impossible to separate them from *C. australis.* If once varieties are freely distinguished, then every other frond must be constituted a variety, based on very slight characters, chiefly as regards size.

The Neocomian examples, figured on Plate IV, fig. 1, and Plate XIV, have comparatively long and fairly distant pinnules. They appear to me to be, however, indistinguishable from *C. australis.* Professor Seward(3) has figured a specimen from the Uitenhage beds of Cape Colony, under the name *Cladophlebis denticulata* (Brongn.) forma *Atherstonei,* in which the pinnules are even longer, but more closely set. Similarly, from the Cretaceous of Greenland, Heer(4) has figured long-pinnuled forms under the names *Pteris longipennis* Heer and *Pteris frigida* Heer, which, except in the denticulate margin, appear to me to be identical with the specimens from Waikato

(1) Seward (1904), p. 171.
(2) Halle (1913[1]), p. 13.
(3) Seward (1903), p. 14, pl. vi, figs. 16, 17.
(4) Heer (1882), pp. 25, 28, pl. vi, fig. 5*b*; pl. x, figs. 1–13; pl. xi; pl. xii, fig. 2; pl. xiii, figs. 1, 2; pl. xvi, figs. 1, 2; pl. xviii, fig. 10*b*.

Heads, New Zealand, which are figured here. Halle(1) has also figured recently, from the Cretaceous of Patagonia, similar pinnæ as *Cladophlebis australis*. A very similar if not identical fossil occurs also in the Cretaceous of the Canadian Rocky Mountains(2).

Cladophlebis australis is almost everywhere in the Mesophytic floras of New Zealand the most abundant of all species, without exception.

Occurrence.—Mount Potts (Rhætic); Clent Hills (Rhætic); McRae's, Makarewa, Hokonui Hills (? Rhætic), Hedgehope, Hokonui Hills (? Rhætic); Owaka Creek, Catlin's River (? Rhætic); Malvern Hills (? Lower Jurassic); Mataura Falls (Lower Jurassic); Curio Bay, Waikawa (Middle Jurassic); Waikato Heads, Auckland (Neocomian).

3. Cladophlebis denticulata (Brongniart). Plate IV, fig. 6.

1828. *Pecopteris denticulata* Brongniart, *Prodr. Hist. Végét. Foss.*, p. 57.
1833–34. *Pecopteris denticulata* Brongniart, *Hist. Végét. Foss.*, p. 301, pl. xcviii, figs. 1, 2.
1833–34. *Pecopteris Phillipsii* Brongniart, *ibid.*, p. 304, pl. cix, fig. 1.
1833. *Neuropteris ligata* Lindley and Hutton, *Foss. Flora*, vol. i, pl. lxix.
1834. *Pecopteris undans* Lindley and Hutton, *ibid.*, vol. ii, pl. cxx.
1834. *Pecopteris insignis* Lindley and Hutton, *ibid.*, vol. ii, pl. cvi
1834. *Pecopteris whitbiensis* Lindley and Hutton, *ibid.*, vol ii, pl. cxxxiv.
1865. *Alethopteris insignis* Eichwald, *Leth. Ross.*, *Péd. Moy.*, p. 15, pl. ii, fig. 6.
1869. *Alethopteris denticulata* Schimper *Traité Pal. Végét.*, vol. i, p. 563.
1869. *Alethopteris insignis* Schimper, *ibid.*, p. 565.
1869. *Alethopteris Phillipsi* Schimper, *ibid.*, p. 564.
1875. *Pecopteris denticulata* Phillips, *Illustr. Geol. Yorks.*, 3rd ed., p. 206, lign. 18.
1875. *Pecopteris Phillipsii* Phillips, *ibid.*, p. 207, lign. 19.
1875. *Pecopteris insignis* Phillips, *ibid.*, p. 206, lign. 17.
1875. *Phlebopteris undans* Phillips, *ibid.*, p. 203, lign. 12.
1878. *Asplenium petruschinense* Heer, *Flor. Foss. Arctica*, vol. v, mem. ii, p. 3, pl. i, fig. 1.
1882. *Pteris frigida* Heer, *Flor. Foss. Arctica*, vol. vi, mem. ii, p. 25, pl. x, figs. 1–4; pl. xi; pl. xii, fig. 2; pl. xiii, fig. 2; pl. xvi, figs. 1, 2.
1882. *Pteris longipennis* Heer, *ibid.*, vol. vi, mem. ii, p. 28, pl. x, figs. 11, 12; pl. xiii, fig. 1.
1889. *Cladophlebis denticulata* Fontaine, *Monogr. xv, U.S. Geol. Surv.*, p. 71, pl. iv, fig. 2; pl. vii, fig. 7.
1896. Cf. *Cladophlebis Roesserti, groenlandica* Hartz, *Meddel. Grönl.*, vol. xix, p. 228, pls. vii–x.
1896. *Cladophlebis Stewartiana* Hartz, *ibid.*, p. 231, pl. xi, figs. 1, 2; pl. xii, figs. 2, 3.
1900. *Cladophlebis denticulata* Seward, *Mem. and Proc. Manchester Lit. and Phil. Soc.*, vol. xliv, No. 8, p. 18, pl. iv, fig. 9.
1900. *Cladophlebis denticulata* Seward, *Jurass. Flora*, vol. i (*Brit. Mus. Cat.*), p. 134, pl. xiv, figs. 1, 3, 4; pl. xv, figs. 4, 5; pl. xx, figs. 3, 4.
1910. *Cladophlebis denticulata* Krystofovic, *Mém. Com. Géol. St. Pétersbourg*, N.S. Livr. 56, p. 5, pl. 1, figs. 1, 1*a*.
1910. *Cladophlebis whitbiensis* Krystofovic, *ibid.*, p. 7, pl. i, figs. 5, 5*a*, 5*b*.
1911. *Cladophlebis denticulata* Thomas, *ibid.*, N.S. Livr. 71, pp. 14, 15, 63, 64, pl. ii, figs. 10–13.
1913. *Cladophlebis denticulata* Halle, *Wissen. Ergeb. Schwed. Südpolar-Exped.*, Bd. iii, Lief. 14, p. 12, pl. ii, figs. 7-9, text-fig. 3.

Diagnosis.—The following diagnosis of this species was given by Seward in 1900 (see above): "Frond bipinnate, large, with long spreading pinnæ attached to a comparatively slender rachis. Pinnules falcate, acutely pointed, usually finely dentate, attached by the whole of the base; the longest pinnules may reach a length of 3–4 cm. Venation of the typical *Cladophlebis* type; a well-marked midrib giving off secondary dichotomously forked veins at an acute angle. Towards the apex of the frond the pinnules are shorter and broader than the longer and narrower segments

(1) Halle (1913²), p. 25, pl. i, figs. 10–13.

(2) Dawson (1886), p. 5, pl. iii, fig. 7.

in the lower and middle portion of the frond. Fertile fronds, similar in form to the sterile; the segments of the same shape, but somewhat straighter, and with an irregularly serrate margin; the sori are oblong in shape and parallel to the secondary veins."

As has already been pointed out (p. 30), *C. denticulata* differs from *C. australis* only in the pinnules having a denticulate margin.

Description of the Specimens.—A single example occurs in the Malvern Hills collection, in which the margins of the pinnules are clearly denticulate. Similar leaflets from Mataura Falls are figured on Plate IV, fig. 6. This is an enlargement of three pinnules seen in a specimen in the British Museum collection (V. 11700). They are falcate, and the margins denticulate. The lateral veins are, as a rule, twice forked.

Remarks.—This species is incidentally mentioned by Kidston and Gwynne-Vaughan(1) as occurring with *Osmundites Dunlopi* in Jurassic rocks near "Gore" (? Waikawa). It is more probable, however, that the species in question was *Cladophlebis australis*. The only other record from the Southern Hemisphere, so far as I am aware, is the undoubted one from Grahamland, which was made quite recently by Halle(2).

Occurrence.—Malvern Hills (? Lower Jurassic); Mataura Falls (Lower Jurassic).

4. Cladophlebis sp. Plate IV, fig. 7.

Description of the Specimen.—A small fragment of a pinna, in which the nervation of the leaflets is clearly marked, is figured twice enlarged on Plate IV, fig. 7. The pinnules are short and fairly broad. Unfortunately this specimen is too imperfect to permit of specific determination.

Occurrence.—Waikato Heads, Auckland (Neocomian).

Genus CONIOPTERIS Brongniart, 1849.

(*Tabl. Végét. Foss.*, p. 26.)

Coniopteris hymenophylloides (Brongniart). Plate II, figs. 1, 2, 3, 6; Plate III, figs. 3, 4, 5, and 9.

1829. *Sphenopteris hymenophylloides* Brongniart, *Hist. Végét. Foss.*, p. 189, pl. lvi, fig. 4.
1829. *Sphenopteris stipata* Phillips, *Illustr. Geol. Yorks.*, 1st ed., p . i, p. 147, pl. x, fig. 8.
1829. *Sphenopteris muscoides* Phillips, *ibid.*, p. 153, pl. x, fig. 10.
1835–36. *Pecopteris Murrayana* Brongniart, *Hist. Végét. Foss.*, p. 358, pl. cxxvi, fig. 5.
1837. *Sphenopteris arguta* Lindley and Hutton, *Fossil Flora*, vol. iii, pl. clxviii.
1837. *Tympanophora simplex* Lindley and Hutton, *ibid.*, pl. clxx A.
1837. *Tympanophora racemosa* Lindley and Hutton, *ibid.*, pl. clxx B.
1851. *Sphenopteris nephrocarpa* Bunbury, *Quart. Journ. Geol. Soc.*, vol. vii, p. 179, pl. xii, figs. 1*a*, 1*b*.
1873. *Sphenopteris Pellati* Saporta, *Pal. Franç.*, vol. i, p. 278, pl. xxxi, fig. 1.
1875. *Sphenopteris Murrayana* (pars) Phillips, *Illustr. Geol. Yorks.*, 3rd ed., p. 212, lign. 26.
1875. *Sphenopteris affinis* Phillips, *ibid.*, p. 213, lign. 30.
1875. *Sphenopteris dissocialis* Phillips, *ibid.*, p. 214, lign. 32.
1875. *Sphenopteris hymenophylloides* Phillips, *ibid.*, p. 215, lign. 34.
1875 *Sphenopteris muscoides* Phillips, *ibid.*, p. 217, pl. x, fig. 10.
1875. *Tympanophora simplex* Phillips, *ibid.*, p. 219, lign. 43.
1875. *Tympanophora racemosa* Phillips, *ibid.*, p. 219, lign. 42.
1876. *Thyrsopteris Murrayana* Heer, *Flora Foss. Arct.*, vol. iv, pt. ii, p. 30, pl. i, fig. 4; pl. ii, figs. 1–4; pl. viii, fig. 11*b*.
1876. *Thyrsopteris Maakiana* Heer, *ibid.*, vol. iv, pt. ii, p. 31, pl. i, figs. 1–3; pl. ii, figs. 5, 6.
1878. *Thrysopteri Murrayana* Heer, *ibid.*, vol. v, pt. ii, p. i, pl. i, fig. 6.

(1) Kidston and Gwynne-Vaughan (1907), p. 759. (2) Halle (1913[1]), p. 12.

Fig. 9. Coniopteris hymenophylloides (Brongn.)
Fertile Frond from Waikawa.
In Dr. P. Marshall's Collection. $\times \frac{3}{2}$.

Fig. 10. Cycadites sp., from Waikawa.
In Dr. P. Marshall's Collection $\times \frac{3}{2}$.

Fig. 11. Podozamites gracilis sp. nova, from Waikawa.
In the New Zealand Geological Survey Collection. Natural size.

1900. *Coniopteris hymenophylloides* Seward, *Jur. Flora*, vol. i, (*Brit. Mus. Cat.*), p. 99, pl. xvi, figs. 4–6; pl. xvii, figs. 3, 6–8; pl. xx, figs. 1, 2; pl. xxi, figs. 1–4.
1904. *Coniopteris hymenophylloides* var. *australica* Seward, *Rec. Geol. Surv. Victoria*, vol. i, pt. 3, p. 163, pl. viii, fig. 6; pl. ix, figs. 7, 9; pl. x, fig. 8.
1911. *Coniopteris hymenophylloides* Thomas, *Mém. Com. Géol., St. Pétersbourg*, N.S. Livr. 71, pp. 13, 62, pl. ii, figs. 3–9; pl. viii, figs. 7–10.
1911. *Coniopteris hymenophylloides* Seward, *ibid.*, N.S. Livr. 75, pp. 10, 38, pl. i, figs. 11–15; pl. vi, figs 67, 68.
1913. *Coniopteris hymenophylloides* Halle, *Wissen. Ergeb. Schwed. Südpolar-Exped.*, vol. iii Lief. 14, p. 19, pl. iii, figs. 23, 24, 27a^2, 27b?, 28–30.

Diagnosis.—The following diagnosis of this species was given by Seward in 1904 (see above): "Frond tripinnate; pinnæ linear acuminate, attached to the rachis at a wide angle; the pinnules vary considerably in size and shape, in some forms they have a few broad and rounded lobes, and in others the lamina is deeply dissected into narrow linear segments. The fertile pinnules bear the sori at the end of the veins; the lamina is usually much reduced, and in extreme cases the fertile segments agree closely with those of *Thyrsopteris elegans* Kze., or *Dicksonia Bertevana* Hook. The sori are partly enclosed in a cup-shaped indusium; the sporangia appear to have an oblique annulus of the cyatheaceous type. The two lowest pinnules of the pinna are often characterized by their unusual shape, the lower half of each pinnule consisting of long spreading and irregular *aphlebia*-like lobes. Venation and form of the frond of the *Sphenopteris* type."

Description of the Specimens.—Portions of the sterile foliage are seen on Plate II, figs. 1–3, and Plate III, fig. 5. These are of quite the normal type, and may be very closely compared with specimens of this species from the English Oolite. Some partly fertile pinnæ are seen on Plate III, fig. 4, natural size, and twice enlarged on fig. 3 of the same plate. In the latter photograph, on the left-hand side, dark oval bodies can be seen at the terminations of some of the pinnule lobes. These are no doubt the sori. The lamina of the pinnules in this specimen is slightly reduced as compared with those shown on Plate II, figs. 1–3.

A somewhat enlarged drawing of another fertile but more reduced pinnule is seen on Plate II, fig. 6.

This species also occurs at Waikawa, where, in addition to fronds with small pinnules like those figured above, others of much larger size are also found. One of these, in Professor Marshall's collection at Dunedin, is identical in size with that figured from Victoria by Seward(1) in 1904. Part of a fertile pinna also occurs on the same specimen, and this is shown by fig. 9. It bears the closest resemblance to a similar fossil, also figured by Seward(2) from the Jurassic of Victoria.

Remarks.—This plant is quite abundant in the Malvern Hill beds. The species is a variable one as regards habit, but, so far as I can see, the New Zealand specimens are indistinguishable from examples from the Jurassic rocks of Europe and Grahamland. The more reduced type of fertile pinnule recalls the specimens from the Jurassic of Victoria (Australia) described by Seward(3) as *Coniopteris hymenophylloides* var. *australica*. The chief feature of this variety is stated to be as follows: "The fertile pinnæ of the European fern are often characterized by a considerable reduction in the lamina, but in this respect there is not a little variation; in the Victorian specimens the fertile pinnæ are practically identical with the sterile, except in the occurrence of sori at the tips of the lobes"(4). In the New Zealand specimens, however, as illustrated here, there appear to be all gradations between sterile pinnules,

(1) Seward (1904[1]), pl. x, fig. 8.
(2) Seward, *ibid.*, pl. ix, fig. 7.
(3) Seward (1904[1]), p. 163, figs. 6–9.
(4) Seward, *ibid.*, p. 164

with unreduced lamina, and fertile leaflets in which the lamina is partly or very largely reduced. I am therefore inclined to refer them to the species *C. hymenophylloides* pure and simple.

Occurrence.—Malvern Hills (? Lower Jurassic); Mokoia, Gore (Lower Jurassic); Curio Bay, Waikawa (Middle Jurassic).

Genus DICTYOPHYLLUM Lindley and Hutton, 1834.

(*Foss. Flora*, vol. ii, pl. civ.)

1. Dictyophyllum acutilobum (Braun). Plate XII, figs. 2–4.

1847. *Diplodictyum acutilobum* Braun, *Flora*, N.S., vol. v, p. 83.

1862. *Camptopteris exilis* Braun, *Palæontogr.*, vol. ix, p. 54, pl. xiii, fig. 11 *a–d.*

1868. *Dictyophyllum acutilobum* Schenk, *Foss. Flora Grenzschich. Keup. & Lias Frank* p. 77, pl. xix, figs. 2–5; pl. xx, fig. 1.

1878–86. *Dictyophyllum acutilobum* Nathorst, *Floran vid Bjuf*, p. 38, pl. xi, fig. 1.

1878. *Dictyophyllum acutilobum* Nathorst, *Floran vid Höganäs och Helsingborg*, pp. 14, 44, pl. i, fig. 8.

1886. *Camptopteris incisa* Hector, *Det. Cat. & Guide, N. Zeal. Court, Ind. & Col. Exhib.*, p. 66, fig. 30*a*(8).

1906. *Dictyophyllum acutilobum* Nathorst, *K. svenska Vet.-Akad. Handl.*, vol. xli, No. 5, p. 13, pl. vi, fig. 24.

Diagnosis.—Schenk (see above) defines this species as follows: Folia petiolata pedata, segmenta digitato-pinnatifida, laciniæ oblongæ pinnatifidæ basi crenatæ, lacineæ secundariæ patentes sinu lato rotundato remotæ integræ obtusæ, inferiores breviores ovato-lanceolatæ, superiores oblongæ subfalcatæ, nervi primarii rigidi validi, secundarii per paria approximati alterni subopposit vel oppositi, angulo recto egredientes apice in rete soluti, tertiarii angulo recto egredientes inter se ad maculas inæqualiter hexagonales conjuncti, appendices in maculas inæquales penta- vel hexagonales conjuncti, ramulis liberis, sori per paginam folii totam inferiorem sparsi rotundi, sporangia tres vel sex, globosa.

Description of the Specimens.—All the examples of this genus from New Zealand are very fragmentary, although it appears to be of common occurrence in more than one locality. The apical fragment of a segment of a frond, figured by Hector in 1886 as *Camptopteris incisa* sp. nov. from the Clent Hills, is refigured on Plate XII, fig. 3. Two larger segments from Mataura Falls are also shown on the same plate, figs. 2 and 4, the latter somewhat enlarged.

Remarks.—In the New Zealand specimens the nerves appear to be rather more prominent than in European examples.

Occurrence.—Mount Potts (Rhætic); Clent Hills (Rhætic); Mataura Falls (Lower Jurassic).

2. Dictyophyllum obtusilobum ? (Braun). Plate VIII, figs. 1 and (?) 10.

1843. *Diplodictyum obtusilobum* Braun, in Münster G., *Beitr. Petrifacten-Kunde*, Heft. vi, p. 14, pl. xiii, figs. 11, 12.

1868. *Dictyophyllum obtusilobum* Schenk, *Foss. Flora Grenzschich. Keup. & Lias Frank.*, p. 75, pl. xvi, fig. 1.

1869. *Dictophyllum obtusilobum* Schimper, *Traité Pal. Végét.*, vol. i, p. 633, pl. xli, fig. 22.

1878–86. *Dictyophyllum obtusilobum* Nathorst, *Floran vid Bjuf*, p. 37, pl. v, fig. 10; pl. vi, figs. 1–4; pl. viii, fig. 3.

Diagnosis.—This species is defined by Schenk (see above) as follows: "Folia . . . ? segmenta profunde pinnatifida oblonga, laciniæ sinu angusto rotundato remotæ integræ oblongæ æquilatæ apice rotundatæ patentissimæ, nervi primarii . . . ?, secundarii excurrentes alterni per paria approximati, tertiarii angulo recto

egredientes maculas inaequaliter hexagonales tri- vel quadri-seriatas formantes, appendicibus anastomosantibus in maculas parvas partiti, sori per totam paginam folii inferiorem sparsa rotunda, verosimiliter in ramulo libero insidentes, sporangia sex vel octo annulo multiarticulato instructa sporae tetraedricae globosae glabrae."

Description of the Specimens.—Two segments of a frond of *Dictyophyllum* are seen on Plate VIII, fig. 1, natural size. The nervation is only faintly preserved, but both in this respect and in the shape of the segments it recalls *Dictyophyllum obtusilobum*, to which I doubtfully refer this specimen. Another fragment is illustrated by fig. 10 of the same plate, also natural size. This shows the median portion of a frond of a *Dictyophyllum*, but it is too fragmentary for specific determination, though it may also be compared with *D. obtusilobum* as regards the nervation.

Occurrence.—Mokoia, Gore (Lower Jurassic).

Genus LINGUIFOLIUM Arber, 1913.

(*Proc. Roy. Soc.*, Ser. B, vol. lxxxvi, p. 346.)

This generic name is proposed for certain Mesozoic plants, which in habit somewhat resemble *Taeniopteris* on the one hand and *Glossopteris* on the other. They differ from the former genus in the lateral veins arising at an acute angle to the midrib, and also in the nerves being somewhat arched and more frequently dichotomized. The shape of the leaf is also spathulate, and not ribbon-shaped. They differ from the latter genus in that the lateral nerves do not anastomose.

The following may be regarded as a provisional diagnosis of the genus: Leaves simple, large, usually tongue-shaped, gradually contracted at the base, margins entire. Midrib strong; lateral nerves arising at a very acute angle to the midrib, more or less arched, frequently dichotomizing, but not anastomosing.

The question will naturally arise whether it would not be better to refer the leaves, here termed *Linguifolium*, to Brongniart's genus *Phyllopteris*, as has indeed been done in regard to at least one other example previously described. At first sight it would appear that the diagnosis of *Phyllopteris* might, with some slight modification, be made to cover fossils similar to the New Zealand specimens. This is undoubtedly the case, but it is of the nature of a "fluke." Any one who is familiar with the reasons why the term *Phyllopteris* Brongn. was instituted is aware that it is a true synonym of *Sagenopteris*, that it was founded under a misapprehension, and that there is good reason to believe that the type of leaf here referred to *Linguifolium* was quite unknown to Brongniart. It seems to me extremely unwise to apply a term instituted for one genus to quite a different one, even if that term be a synonym. Further, as I have said, it is merely chance that the diagnosis of *Phyllopteris* happens also to fit *Linguifolium*, a type of frond unknown until much later. *Phyllopteris* has tended to create confusion and to prolong misunderstanding in the past, and thus for the future it is best avoided. Though Saporta has applied this term to real members of the genus *Linguifolium*, I am not inclined to follow his example, for I believe the best thing to be done in such circumstances is to abandon entirely the old term, and to start afresh with a new name, and thus at least avoid confusion.

The history of *Phyllopteris* may be stated briefly as follows: In 1830 Brongniart, in his *Histoire des Végétaux fossiles*(1), figured two plants, *Glossopteris Phillipsii* Brongn. and *G. Nilsoniana* Brongn., which he believed to be new. The second, however, is identical with a more complete specimen afterwards figured by Presl(2) as *Sagenopteris rhoifolia* Presl, and both were shown later to belong to the genus *Sagenopteris* Presl, and

(1) Brongniart (1828), vol. i, p. 225, pl. 61 *bis*, fig. 5; pl. 63, figs. 2, 3.

(2) Presl in Sternberg (1820), Heft 7, p. 164 pl. 35, fig. 1, 1838.

not to *Glossopteris* Brongn. In a later paper, however, in 1849, Brongniart(1) transferred both these plants, the one Rhætic and the other Jurassic, to a new genus *Phyllopteris*, distinct from *Glossopteris* and *Sagenopteris*, as he expressly states. Brongniart was at that time under the impression that the lateral nerves did not anastomose in these two species, a quite erroneous conclusion founded on the inaccurate representations of the nervation of these plants given in some of the earlier illustrations by Phillips and others. It has been known, however, for many years past that a reticulate lateral nervation is a constant character of *Sagenopteris*, and, further, that the two species in question are still the most typical members of that genus. Thus *Phyllopteris* is a synonym of *Sagenopteris*, founded under a misapprehension.

In 1873 Saporta(2) revived this term for quite a different plant, which is a true *Linguifolium*; hence the present confusion which I wish to avoid. Saporta has been followed by Etheridge(3) in regard to a South Australian type.

Other members of *Linguifolium* have been already figured from various parts of the world, though not referred to *Phyllopteris*. The most important of these are the fragmentary leaves from the Rhætic rocks of La Ternera, Chile, referred by Solms(4) to the genus *Lesleya*, as *L. Steinmanni* Solms. It must be confessed that the above specimens, as also those from New Zealand here under consideration, very closely resemble the Palæozoic plants referred to the genus *Lesleya* by Lesquereux(5), Grand' Eury(6), and Zeiller(7). Apart from the difference in size, which is no doubt not of generic value, the larger fronds of Europe differ from the Rhætic specimens chiefly in the lateral veins being finer, closer, more numerous, and more frequently branched. It will be a matter of opinion, no doubt, as to whether these differences, in combination with dissimilarity in geological age, are sufficient to warrant generic separation; but, despite the fact that it does not appear possible to distinguish the two types by more definite characters, I am so impressed by the difference in habit that I would refer the Rhætic specimens to a distinct genus. For this I have recently proposed(8) the name *Linguifolium* gen. nov., by which is intended to be implied simply "tongue-shaped leaf." *Linguifolium* may also be compared with *Copiapœa plicatella* Solms(9), from the Rhætic of Chile, which may perhaps be regarded as a species in which the nerves are more distant.

Among Australian specimens, the *Phyllopteris Feistmanteli* of Etheridge(10) is certainly a *Linguifolium*, closely similar to *Linguifolium Lillieanum*. The *Neuropteris punctata* of Shirley(11) may be either a member of this genus or more probably a *Danæopsis*. The basal portions of the leaves are not preserved, and it is therefore impossible to say whether in this fossil the leaves were simple or compound.

The fragmentary specimen figured by Seward(12), from the Jurassic rocks of Victoria, as *Thinnfeldia* sp., appears to be a *Linguifolium*, very close to if not identical with *L. Lillieanum*. The *Pterophyllum dubia* (*sic*) of Johnston(13) from Tasmania may be also of a similar nature.

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(1) Brongniart (1849), pp. 22, 103–105.
(2) Saporta (1873), vol. i, p. 448, pl. lxiii, fig. 6.
(3) Etheridge (1892), p. 3, pl. —, figs. 1, 2.
(4) Solms (1899), p. 596, pl. xiii, figs. 5–7.
(5) Lesquereux (1879), p. P 143, pl. xxv, figs. 1–3.
(6) Grand' Eury (1890), p. 305, pl. viii, fig. 5; Croq. F., p. 305.
(7) Zeiller (1890), p. 166, pl. xiii, fig. 2; Renault and Zeiller (1888), p. 285, pl. xxiii, fig. 6.
(8) Arber (1913[1]), p. 346.
(9) Solms (1899), p. 594, pl. xiii, figs. 8–11. Compare also the nervation of the Permo-Carboniferous *Blechnoxylon talbragarense* Etheridge (1899), p. 135, pl. xxiv, figs. 1, 2, 3.
(10) Etheridge (1892), p. 3, pl. —, figs. 1, 2.
(11) Shirley (1898), p. 20, pl. xiv, fig. 2.
(12) Seward (1904), p. 175, pl. xvii, fig. 29.
(13) Johnston (1887), p. 176; (1888), pl. xxvii, fig. 6. *Cf.* also Johnston (1896), p. 58, pl. —, figs. 5, 6, 7, *Strzeleckia gangamopteroides* Johns., which, however, has apparently no midrib.

The simple leaves of *Linguifolium* also have a considerable resemblance to the pinnules of *Danæopsis rajmahalensis* Feist.(1), a compound frond from the Rajmahal Hills of India. There is no evidence, however, that the New Zealand specimens formed part of a pinnate frond. The following is a list of the plants previously described which I regard as species of *Linguifolium: Linguifolium plumula* (Sap.)(2), *Linguifolium Steinmanni* (Solms)(3), *Linguifolium Feistmanteli* (Ether.)(4).

Professor Seward(5), in a criticism of my previous note on the Mount Potts flora, speaking of the fossils here termed *Linguifolium*, says, "while admitting the almost complete absence of anastomoses, I believe that in one or two cases there are actual cross-connections, and that the fronds are very closely related to such species as *Glossopteris indica* and *G. Browniana*." I am inclined, however, to regard such anastomoses as apparently occur as accidents of preservation, as I pointed out in a former note(6). Seward, however, appears to lay great stress on such cases of anastomoses of the veins as he can find, which he admits are rare, in the hope of proving this plant to be a *Glossopteris*. He says, "the leaves on which the genus *Linguifolium* is founded are, I believe, if not generically identical with, at least very closely related to, *Glossopteris*." In support of this view he cites some well-known cases among Permo-Carboniferous Glossopterids, in which the anastomoses are undoubtedly few or missing(7). The occurrence of such specimens is in no way remarkable. Whether the finer veinlets of the anastomoses are or are not preserved depends on the perfection of preservation exhibited by a particular specimen. No good case of an undoubted Glossopterid has yet been brought forward in which the absence or rarity of anastomoses cannot be well explained as the result of imperfect preservation of the nervation. Exactly the same thing is of the commonest occurrence among Tertiary dicotyledonous leaf-impressions. In such fossils the chief diagnostic characters are usually found in the delicate veins of the third or higher orders, yet as often as not these are not preserved, even when the coarser veins are well marked. Thus, if a specimen is found in Permo-Carboniferous beds in Gondwanaland in which the anastomoses are indistinct or absent, but which otherwise corresponds to *Glossopteris*, we may agree that it is probably only an imperfectly preserved member of that genus, which does not merit specific determination. Seward might apply this argument very fairly to *Linguifolium* did it occur in Permo-Carboniferous rocks, though if the limits of *Glossopteris* are to be so greatly enlarged it will have to include also *Blechnoxylon* among other types, which does not seem to me to be advisable. But as Seward appears to agree, *Linguifolium* occurs not in Permo-Carboniferous but in Mesozoic beds in New Zealand, and, as I have shown here, probably as late as the Jurassic period. Among Mesozoic plants there are several—such as the South American specimen referred to *Lesleya* by Solms, and the Australian fossil assigned to *Phyllopteris* by Etheridge, as I have pointed out above—which are very similar in habit to *Linguifolium*, but I do not imagine that any one would dream of including these in *Glossopteris*. Certainly such a suggestion has not yet been made. So far as I can judge, the New Zealand plant agrees far better with these Mesozoic types than with *Glossopteris*, which is entirely unknown from the Jurassic. For the present, seeing that in the great majority of cases, as Seward admits, there are no signs of anastomoses among the nerves of *Linguifolium*, it is better to compare them with genera which reached their maximum during the *same* geological age than to lay undue

(1) Feistmantel (1877), vol. i, pt. ii, p. 53, pl. xxxviii, figs. 4, 4*a*.
(2) Saporta (1873), vol. i, p. 450, pl. lxiii, fig. 6.
(3) Solms (1899), p. 596, pl. xiii, figs. 5–7.
(4) Etheridge (1892), p. 3, pl. —, figs. 1, 2.
(5) Seward (1914), p. 38.
(6) Arber (1913[1]), p. 345, footnote.
(7) Zeiller (1902), p. 11, pl. iii, fig. 3; also Seward and Leslie (1908), p. 113, pl. ix, fig. 2 and text-figs. 2, 3; Seward (1910), p. 508, fig. 342.

weight on the possible occurrence of a few anastomoses which are, quite as likely as not, artificial and not real, and thus to include them in a genus (*Glossopteris*) which reached its maximum at an *earlier* geological period. On my view it is by no means safe to assume that the two plants are "very closely related," and it is better to maintain a non-committal attitude, or even to suggest a distinct origin by placing the New Zealand fossils in a distinct genus.

Linguifolium Lillieanum Arber. Plate III, figs. 1, 7.

1913. *Linguifolium Lillieanum* Arber, *Proc. Roy. Soc. London*, ser. B, vol. lxxxvi, p. 346, pl. 7, figs. 1, 4.

Diagnosis.—Leaves spathulate, up to 9 cm. or more in length, and 1·7–3 cm. across at their greatest width. Margins entire, apex rounded, leaf gradually tapering to an elongate base; midrib well marked, persisting to the apex. Lateral veins arising at an acute angle to the midrib, arching upwards and then bending to the margin, once or twice forked, about 1 mm. apart.

Description of the Specimens.—The specimens are all fragmentary, and no complete leaf occurs. A median portion of a leaf is seen enlarged on Plate III, fig. 1. This shows the midrib and the lateral nervation. Here and there, in this specimen, it appears at first sight as if the lateral nerves anastomose. I am, however, convinced that, in this as in other cases, the appearances are deceptive. Some of them arise from the imperfect removal of the film of carbon covering the frond. The little strips of carbon which remain in some cases simulate nerves. In others the leaf did not lie quite flat on the matrix before preservation took place, and this has led to a squeezing of the lamina, the lateral nerves thus becoming approximated. At the top right-hand corner of this specimen the irregularity and the apparent union of the nerves appears to be due to both causes. At any rate, in the great majority of cases there is no anastomosis, and wherever such apparent unions are seen they may be explained in one of the two ways above indicated. The nervation is best seen in fig. 7 of Plate III, which shows two portions of rather small leaves, in which the lateral nerves are fairly clear, though the film of carbon still largely adheres to the lamina. The dichotomy of the nerves is only occasional. This photograph is somewhat enlarged.

Remarks.—I am inclined to regard *L. Lillieanum* as specifically distinct from any of the previously described members of the same genus indicated on p. 37. It, however, stands nearest to the South Australian *L. Feistmanteli* (Ether.). I have only seen one example from the Malvern Hills, and this belongs to the Canterbury Museum, Christchurch, New Zealand. The nervation is here clearly seen, and, so far as one can judge, this specimen is identical with those occurring at Mount Potts.

Type in the British Museum (Natural History).

Occurrence.—Mount Potts (Rhætic). Malvern Hills (? Lower Jurassic); in the Canterbury Museum, Christchurch, New Zealand.

Genus MICROPHYLLOPTERIS gen. nov.

Among the fern-like fronds of Mesophytic age occurring in New Zealand there are specimens which by most authors would be unhesitatingly referred to the genus *Gleichenites* Gœpp. Similar fronds are found not infrequently in Mesozoic rocks elsewhere, and have been generally regarded as the leaves of ferns closely allied to, if not identical with, the modern fern *Gleichenia*. This may be the case, but, so

far as the present evidence of the earlier Mesozoic examples is concerned, it must be admitted that it rests entirely on a similarity of frond-habit (which is notoriously untrustworthy as a guide to affinity) and not on any precise knowledge of the fructification. Further, there is little doubt that the genus *Gleichenites*, even if it is to include the Mesophytic types in question, is a thoroughly bad one, incapable of being defined compactly or concisely. If we look into the origin of the term we find that it was instituted for Palæozoic plants now long ago transferred to other genera.

The genus was founded in 1836 by Gœppert(1), who briefly diagnosed it as follows: "Frons dichotoma pinnata. Fructificatio hucusque ignota." He described five species, all of Palæozoic age, one species being of Lower Carboniferous, three of Upper Carboniferous, and one of Permian age. Several of these plants had already been ascribed to other genera, and they have since been finally referred to *Eremopteris*, *Sphenopteris*, &c.

In 1860 Eichwald(2) recorded one of Gœppert's species, the well-known *Eremopteris artemisiæfolia* (Sternb.), from Russia, and a new species, which is apparently a Palæozoic species of *Sphenopteris*, from the same country.

These are the chief attributions of Palæozoic plants to the genus *Gleichenites*, and, as we have seen, none of them can stand. In more recent years other authors have applied this same name to Mesozoic plants of quite different affinity to those enumerated by Gœppert.

One of the first of these was the Upper Gondwana plant of India described by Oldham(3) in 1860 as *Pecopteris (Gleichenites) linearis*, and in 1862 by Oldham and Morris(4) as *Pecopteris (Gleichenites) gleichenoides*. Schimper(5) subsequently changed the specific name, and placed this plant in the living genus *Gleichenia* itself; but Feistmantel(6) more cautiously described it as *Gleichenites (Gleichenia) Bindrabunensis* (Schimper). This species I propose to term *Microphyllopteris gleichenoides* (Old. & Morr.). It has also been recorded by Etheridge(7) from Australia, and referred by him to yet another genus.

In 1865 de Zigno(8) described a new plant with a dichotomously branched frond, from the Jurassic of Italy, under the name *Gleichenites elegans*. Schimper(9) in 1869 also transferred this fossil to the genus *Gleichenia*. This plant I propose in future to term *Microphyllopteris elegans* (Zigno). As de Zigno pointed out, it is also possible that the very incomplete fragment of a frond from the Jurassic of Mamers, France, figured by Brongniart(10) as *Pecopteris Desnoyersii* in 1836, may be related to the Italian fossil generically, but at present the material is too imperfect to allow of any definite conclusions on this point.

The American Triassic *Neuropteris linnææfolia* of Bunbury(11), from the Richmond coalfield of Virginia, of which additional specimens have been figured by Fontaine(12) under the name *Acrostichides linnææfolius*, is no doubt another species of *Microphyllopteris*.

The obscure *Gleichenites microphyllus* of Schenk(13), from the Rhæto-Lias of Germany, may be a further representative of the genus, and another is perhaps Heer's(14) *Pecopteris gracilis*, from the Keuper of Neuewelt, near Basle, referred more recently by

(1) Gœppert (1836), p. 181.
(2) Eichwald (1860), vol. i, pp. 90, 91, pl. ii, figs. 5, 6.
(3) Oldham (1860), p. 324.
(4) Oldham and Morris (1862), p. 45, pl. xxv; pl. xxvi figs. 1, 3.
(5) Schimper (1869), vol. i, p. 670.
(6) Feistmantel (1877[1]), pp. 41–93.
(7) Etheridge (1888), p. 1307, pl. xxxviii, fig. 3.
(8) de Zigno (1856), vol. i, p. 193, pl. x.
(9) Schimper (1869), p. 670.
(10) Brongniart (1828), p. 366, pl. cxxix, fig. 1.
(11) Bunbury (1847), p. 281, pl. x.
(12) Fontaine (1883), p. 25, pl. vi, fig. 3; pl. vii, figs. 1–4; pl. viii, fig. 1; pl. ix, fig. 1.
(13) Schenk (1867), p. 86, pl. xxii, figs. 7, 8.
(14) Heer (1865), p. 54, pl. ii, fig. 1.

Leuthardt(1) to the genus *Gleichenia.* Here the sori can be seen, but the characters of the sporangia have not been determined. This is the only case, so far as I am aware, in which the sori have been observed in any pre-Cretaceous species of this type of frond.

In Lower Cretaceous rocks this type of frond is more abundant than in the Jurassic, and numerous specimens have been figured by Schenk, Heer(2), Nathorst(3), Debey and Ettingshausen(4), and others. Recently, Halle(5) has described two species from the Cretaceous of Patagonia, and Seward(6) another from the Jurassic of Scotland. Many of these have been referred to the genus *Gleichenites.*

I am well aware that, in the case of some of the Cretaceous and Tertiary fronds referred to *Gleichenites,* there are much better grounds for the belief in affinity to the living *Gleichenia* than exist in the case of the Jurassic species. My view is that if this term is used at all it is best preserved for cases where some further evidence than similarity of leaf-form has been found to exist.

As regards the Jurassic examples from New Zealand, there is the choice either of following others blindly in referring them to the genus *Gleichenites* (despite the absence of any real evidence of affinity with *Gleichenia,* and the thoroughly bad nature of the genus, as originally used for what are now thought to be Palæozoic Pteridosperms) or of applying some new non-committal name to them. The former course may simplify the synonymy, but the latter appears to me to be far more scientific. A third possibility, of emending Gœppert's generic diagnosis out of all recognition, does not seem to me justifiable. I have therefore decided to refer these plants to a new genus, *Microphyllopteris,* by which term I imply simply ferns with small leaflets.

Diagnosis.—Fronds pinnate, bipinnate, or dichotomously branched; pinnules small or very small, subcircular or ovate, closely set, broadest at the base, and attached by their whole base. Median nerve feeble, breaking up into simple or forked branches not far from the base of the pinnule.

1 Microphyllopteris pectinata (Hector). Plate VII, figs. 3–6, 8–11.

1886. *Lomarites pectenata* Hector, *Det. Cat. & Guide, N. Zeal. Court, Ind. & Col. Exhib.,* p. 66, fig. 30A(5).

Diagnosis.—Frond bipinnate?; pinnæ 8 cm. or more in length; rachis fairly stout, sometimes grooved, bearing subopposite or alternate small rounded pinnules, about 6 mm. long and up to 5 mm. across. Pinnules somewhat thick. Lateral nerves forking once or twice.

Description of the Specimens.—All the examples of this plant from the Mataura Falls beds (Plate VII, figs. 8 and 10) are poorly preserved, and in none of them is the nervation seen. Much better specimens, of what I take to be the same plant, occur in the Neocomian rocks of Waikato Heads, Auckland, and on these the above diagnosis is chiefly founded.

Of these, two specimens in the New Zealand Survey collection are shown in Plate VII, figs. 4 and 11, the former twice enlarged, the latter natural size. A part of fig. 11 is also seen, four times enlarged, on fig. 6 of the same plate, to show the nervation. The pinnules are subcircular, and about 4 mm. in length. The lateral nerves fork widely.

(1) Leuthardt (1903), pt. ii, p 40, pl. xviii, figs. 3, 3*a*.
(2) Heer (1874), p. 43, pl. iv–x, &c.
(3) Nathorst (1890), p. 8, pl. iv, figs. 3–5.
(4) Debey and Ettingshausen (1859), p. 6, pl. 1.
(5) Halle (1913 2), pp. 22–23, pl. 1, figs. 14–18.
(6) Seward (1911), p. 664, pl. iii, figs. 48–58*a*; pl. v, figs. 87–89, 92–96; text-fig. 5.

Another similar specimen in the British Museum collection is shown on Plate VII, fig. 3 (natural size). The pinnules are here rather more oval in form.

Two further examples, both in the British Museum collection, are shown on the same plate, figs. 5 and 9, both somewhat enlarged. These show bipinnate leaves, the pinnæ being alternate. In fig. 5 four pinnæ are seen attached to the rachis, and the nervation of some of the pinnules is fairly clear. Fig. 9 is a similar but less distinct specimen. These two examples may eventually prove to belong to a distinct species, though from the similarity in the nervation of the pinnules I am inclined for the present to attribute them to *Microphyllopteris pectinata* (Hect.).

Remarks.—This plant agrees well in habit with the Indian *Microphyllopteris gleichenoides* (O. & M.), but the pinnules are at least twice as large. The nervation, however, corresponds with that of the Indian plant shown on plate xxv, fig. 1*a*, of Oldham and Morris's memoir. This is also the case as regards *M. elegans* (de Zigno), from the Jurassic of Italy, where, however, the habit is quite distinct, irregular dichotomies being a marked feature of the frond.

The Waikato Heads specimens may be closely compared with the *Gleichenites obtusata* of Heer(1), from the Cretaceous of Greenland, and with some of the other examples of the same genus from various parts of the world (see pp. 39, 40), especially from Cretaceous sediments.

Types.—New Zealand Geological Survey collection.

Occurrence.—Mataura Falls (Lower Jurassic); Waikato Heads (Neocomian).

2. Microphyllopteris sp. Plate II, fig. 10.

Description of the Specimen.—A single badly preserved pinna of this genus, occurring in the Catlin's River collection, is figured on Plate II, fig. 10, natural size. It measures 3·6 cm. in length. The form of the subcircular pinnules is seen, but the nervation is indistinct.

Remarks.—It is possible that this specimen should be more correctly referred to the genus *Thinnfeldia*, though I am inclined to regard it as an example of *Microphyllopteris*, on account of the small size of the pinnules.

Occurrence.—Owaka Creek, Catlin's River (? Rhætic).

Genus SPHENOPTERIS Brongniart, 1822.

(*Sur. Class. Végét. Foss.*, p. 233.)

1. Sphenopteris Currani ? (Tenison-Woods). Plate II, figs. 7, 8.

1883. *Alethopteris Currani* Tenison-Woods, *Proc. Linn. Soc. N.S. Wales*, vol. viii, p. 113, pl. vi, fig. 4.

Diagnosis.—Frond bipinnate; pinnæ alternate, lanceolate; pinnules alternate, oblique, ovate or ovate-lanceolate, delicate, crenate, or roundly lobed. Median nerve impersistent at apex, lateral nerves forked.

Description of the Specimens.—The single example of this plant in the Sedgwick Museum from Gore is figured on Plate II, fig. 7, natural size, and a single pinnule is shown $2\frac{1}{2}$ times enlarged on fig. 8 of the same plate. The frond measures 9·7 cm. in length, and the pinnæ are about 3·5 cm. long, or less. The whole texture of the lamina is very delicate. The higher pinnæ are only lobed, the lower are divided into ovate pinnules with crenulate margins.

(1) Heer (1882), p. 37, pl. xxx, figs. 7–16.

Remarks.—This plant may be a new species, and not identical with *S. Currani* (Ten.-Woods), of which only a fragment of a pinna is known. If, however, the lower left-hand pinna seen in fig. 7 be compared with Tenison-Woods's illustration, it will be seen that there is very close agreement, and for this reason I am inclined to think that the two fossils may be identical.

Occurrence.—Mokoia, Gore (? Lower Jurassic).

2. Sphenopteris (Ruffordia) Gœpperti Dunker. Plate I, figs. 2, 4.

1833. *Sphenopteris Phillipsii* Mantell, *Geol. S.E. England*, p. 239, fig. 2.
1844. *Cheilanthites Goepperti* Dunker, *Über Norddeutsch. Sogen. Wälderthon*, &c., p. 6.
1846. *Sphenopteris Göpperti*, Dunker, *Monogr. Norddeutsch. Wealdenbild.*, p. 4, pl. 1, fig. 6 pl. ix, figs. 1–3.
1846. *S. Hartlebeni* Dunker, *ibid.*, p. 4, pl. ix, fig. 9.
1846. *S. longifolia* Dunker, *ibid.*, p. 4, pl. viii, fig. 6.
1852. *Sphenopteris Jugleri* Ettingshausen, *Abhandl. k.-k. geol. Reichs*, Bd. i, Abth. iii, No. 2, p, 15, pl. iv, fig. 5.
1869. *Sphenopteris (Davall.) Hartlebeni* Schimper, *Traité Pal. Végét.*, vol. i, p. 393, pl. xxx, figs. 2, 3.
1871. *Sphenopteris Göpperti* (pars) Schenk, *Palæontogr.*, vol. xix, p. 209, pl. xxv, figs. 2–5.
1876. *Sphenopteris Auerbachi* Trautschold, *Nouv. Mém. Soc. Nat. Moscou*, vol. xiii, p. 207, pl. xviii, fig. 5.
1878. *Sphenopteris Göpperti* Dupont, *Bull. Acad. Roy. Belgique*, ser. ii, vol. xlvi, p. 396.
1881. *Sphenopteris valdensis* (pars) Heer, *Sect. Trav. Géol. Portugal*, 4to, p. 14, pl. xv, fig. 11, ? figs. 9, 10, 12–14.
1890. *Sphenopteris* cfr. *Göpperti* Nathorst, *Denkschr. k. Akad. Wissen. Wien (Math.-Nat. Cl.)*, vol. lvii, p. 51, pl. vi, figs. 2, 3.
1890. *Sphenopteris* sp. Yokoyama, *Journ. Coll. Sci. Tokyo*, vol. iii, p. 34, pl. xiv, figs. 13, 13*a*.
1894. *Ruffordia Göpperti* Seward, *Wealden Flora*, pt. i, p. 76, pl. iii, figs. 5–6; pl. iv; pl. v; pl. vi, figs. 1, 1*a*.
1900. *Ruffordia Göpperti* Seward, *Jurassic Flora*, pt. i, p. 133.
1900. *Ruffordia Goepperti* Seward, *Mém. Mus. Roy. Hist. Nat. Belgique*, vol. i, p. 18, pl. iii, fig. 33.
1913. *Sphenopteris (Ruffordia ?) Goepperti* Halle, *Wissensch. Ergebn. Schwed. Südpolar-Exped.*, Bd. iii, Lief. 14, p. 25, pl. iii, fig. 9.
1914. *Sphenopteris (Ruffordia) Gœpperti*, Zeiller, *Rev. génér. Botan.*, vol. xxv *bis*, p. 451, pl. 20, fig. 2.

Diagnosis.—The following diagnosis of this species was given by Seward in 1894 (see above): "Frond tripinnate-quadripinnate, deltoid or rhomboidal, rachis frequently flexuous, pinnæ alternate, deltoid to ovate-lanceolate; pinnules delicate, decurrent on the rachis, ultimate segments linear acuminate or ovate-cuneate. Venation of the type *Cœnopteridis* and *Sphenopteridis*. Fructification in the form of scattered sporangia on fertile fronds or pinnæ, of which the leaf lamina is considerably reduced."

Description of the Specimens.—A small portion of a sterile frond of *Sphenopteris Gœpperti* is seen on Plate I, fig. 2. Another is shown by fig. 4 of the same plate, also natural size. The latter has rather broader segments, but, on the whole, despite the imperfection of the preservation, I am inclined to regard it as another example of *Sphenopteris Gœpperti* Dunk.

Occurrence.—Mokoia, Gore (? Lower Jurassic).

3. Sphenopteris gorensis sp. nov. Plate II, fig. 4.

Diagnosis.—Frond pinnate; rachis slender; pinnules opposite, more or less wedge-shaped, very broad in proportion to their length, contracted at the base; lamina deeply dissected into broad wedge-shaped lobes, which are themselves often broadly toothed or lobed.

Description of the Specimen.—The single example of this frond from Gore is figured on Plate II, fig. 4, natural size. The pinna measures 7·4 cm. in length. The rachis is slender and perhaps grooved. The pinnules measure about 1·5 cm. in length, but vary somewhat in breadth, being about 1 cm. across at the broadest part near the base in the lowest pinnules seen in fig. 4, but narrower in the case of the higher pinnules. They are deeply dissected into a large number of small, wedge-shaped, contiguous segments, broadest at the apex, and these segments are again often toothed or lobed.

Type.—Sedgwick Museum, Cambridge.

Occurrence.—Mokoia, Gore (? Lower Jurassic).

4. Sphenopteris otagoensis sp. nov. Plate 1, figs. 5, 6, 8; Plate V, fig. 7.

Diagnosis.—Frond bi- or tri-pinnate; rachis of ultimate pinnæ grooved, slender. Pinnules subopposite or alternate, between 1 cm. and 2 cm. in length, lobed, contracted at the base; lobes rather broad, rounded or rather acute at the apex. Nervation of the ordinary Sphenopterid type.

Description of the Specimen. — This plant, which resembles some Palæozoic *Sphenopterids* more closely than any Mesozoic species of the genus with which I am acquainted, is represented by several specimens. A photograph of one of these is seen on Plate V, fig. 7, twice enlarged. Drawings of two others will be found on Plate I, figs. 6 and 8, both natural size. An enlarged drawing of the nervation is seen on Plate I, fig. 5.

Remarks.—This species may be related to, or even identical with, *S. owakaensis*, though on the present material I am inclined to regard them as distinct.

Type.—New Zealand Geological Survey collection.

Locality.—Owaka Creek, Catlin's River (? Rhætic).

5. Sphenopteris owakaensis sp. nov. Plate V, fig. 8.

Diagnosis.—Rachis slender. Pinnules broadly ovate, 12 mm. long and 7 mm. to 8 mm. broad at the base, contracted at the base; margin lobed, about three lobes on each side; lobes rounded; terminal lobe small. Nerves supplying the lower lobes arising directly from the rachis; median nerve impersistent, giving off at an acute angle numerous, strong, erect, and branched lateral nerves which fork widely.

Description of the Specimen.—This species is founded on a single specimen consisting of 4 or 5 pinnules, part of which is seen enlarged three times on Plate V, fig. 8, to show the nervation.

Type.—New Zealand Geological Survey collection.

Occurrence.—Owaka Creek, Catlin's River (? Rhætic).

6. Sphenopteris sp. Plate III, fig. 6; Plate V, figs. 3, 9.

Description of the Specimens.—A very small fragment of a *Sphenopteris* frond, from the Malvern Hills, is figured on Plate III, fig. 6, twice enlarged. The lobes of the pinnules appear to be short but broad. This specimen is, of course, quite indeterminable specifically. I figure it here as being a somewhat unusual type of frond from the Mesozoic rocks.

Another species of *Sphenopteris* (Plate V, figs. 3 and 9, both twice enlarged) occurs in the Hokonui Hills. The pinnules here are oval, slightly lobed, and contracted at the base. Each has a median nerve, and the lateral nerves dichotomize twice, or even three times. Both these specimens, however, are too fragmentary for specific determination.

Occurrence.—Malvern Hills (? Lower Jurassic); McRae's, Hokonui Hills (? Rhætic).

Genus TÆNIOPTERIS Brongniart, 1828.

(*Prodr. Hist. Végét. Foss.*, p. 61.)

Some species of *Tæniopteris,* in which the leaves are large and broad, have been referred to separate genera—such as *Macrotæniopteris* Schimper, *Angiopteridium* Schimper, *Stangerites* Bornemann—by many authors, and more especially by Schimper and Feistmantel. As I pointed out, however, in 1905(1), there are no good characters which clearly distinguish these genera from *Tæniopteris,* and certainly the size and shape of the leaf alone are untrustworthy data on which to base generic distinctions. I therefore prefer to include all such fossils within the single genus *Tæniopteris.*

1. Tæniopteris arctica Heer. Plate VI, figs. 1, 6; Plate VII, figs. 5, 9.

1872. *Tæniopteris arctica* Heer, *Öfvers. k. Vet.-Akad. Förhandl.* for 1871, p. 1181.
1874. *Oleandra arctica* Heer, Kreide Flora Arct. Zone (*Flora Foss. Arctica,* vol. iii, mem. ii), p. 38, pl. xii, figs. 3–11.
1891. Cf. *Oleandra arctica* Newberry, *Amer. Journ. Sci.,* vol. xli, p. 201, pl. xiv, fig. 9.
1903. *Tæniopteris* sp. (cf. *Tæniopteris arctica*) Seward, *Ann. S. Afric. Mus.,* vol. iv, pt. 1, p. 19, pl. ii, figs. 5, 5*a*.

Diagnosis.—The following diagnosis was given by Heer in 1874 (see above): "Foliis coriaceis, petiolatis, lineari-lanceolatis, basin et apicem versus sensim attenuatis, acumimatis, integerrimis nervo medio valido, nervis secundariis horizontalibus, numerosis, dichotomis; soris rotundatis, biseriatis, nervo medio approximatis."

Description of the Specimens.—In Plate VI, fig. 1, several leaves are seen, twice enlarged. The longest frond is 5 cm. long, and about 1 cm. broad. The midrib is fairly strong, and the lateral nerves are very clear, distant, and once forked; the branches of the forks being distant. Fig. 6 of the same plate illustrates a narrower type of frond, natural size. Two other specimens, in the British Museum collection, are shown by figs. 5 and 9 of Plate VII, both somewhat enlarged.

Remarks.—Fragments of this frond also occur on the large specimen figured in Plate XIV, but are not seen in the photograph.

This species in some respects very closely resembles *T. Daintreei* McCoy in habit. It differs, however, in the nervation, the nerves being conspicuous and comparatively distant, forking either near the midrib or at any point between the midrib and margin.

The New Zealand specimens appear to me to agree very closely with the fronds from the Cretaceous of Greenland figured by Heer in 1874 (see above), especially the fig. 3 of plate xii of that memoir. They also somewhat resemble the specimen from the Uitenhage Series of Cape Colony, figured by Seward in 1903, and doubtfully referred to Heer's species.

Occurrence.—Waikato Heads, Auckland (Neocomian).

(1) Arber (1905), p. 120.

2. Tæniopteris crassinervis (Feistmantel). Plate IX, fig. 4; Plate X, figs. 1–3, 5.

1877. *Macrotæniopteris crassinervis* Feistmantel, *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. i (2), p. 102 (50), pl. xxxviii, figs. 1, 2, 2*a*, 2*b*, 3.

1883. *? Macrotæniopteris crassinervis* Fontaine, *Monogr. vi, U.S. Geol. Surv.*, p. 22, pl. v fig. 5; ? pl. vi, figs. 1, 2.

1886. *Macrotæniopteris lata* Hector, *Det. Cat. & Guide, N. Zeal. Court, Ind. & Colon. Exhib.* p. 66, fig. 30*a*(4).

1892. *Macrotæniopteris crassinervis ?* Etheridge, in Jack and Etheridge, *Geol. & Pal. Queensland*, p. 376, pl. xvi, fig. 5.

1898. *Macrotæniopteris crassinervis* Dun, *Rep. Austr. Assoc. Adv. Sci. Sydney*, vol. vii, p. 398.

Diagnosis.—Fronds with long petioles, very variable in size, from 8 cm. to 19 cm. or more in length, and 1·5 cm. to 8 cm. or more broad. Apex obtuse or obtusely pointed; base suddenly contracted, margins wavy; lamina coriaceous. Midrib stout, up to 1 cm. broad; lateral nerves very stout, ½ mm. across, about 8 to 12 in 1 cm. of length of frond, generally arising at right angles to the midrib, single or once forked.

Description of the Specimens.—The very complete specimen figured on Plate X, fig. 1, about half natural size, gives a very good idea of the mature frond of this species. It is the type of Hector's (not Oldham and Morris's) *Macrotæniopteris lata.* The apex is not quite perfect, and not more than 3 cm. of the rachis is seen at the base. The length of the lamina is 19 cm., and its greatest breadth 6·6 cm. The midrib near the base is 4 mm. across, fairly smooth, at any rate not striated. The nerves are strong (½ mm. across) and fairly distant, about 10 in each centimetre of length. The nerves are simple for the most part, with occasionally a single dichotomy, the limbs of the forks being widely separated. In the greater part of the lamina the lateral nerves arise at right angles to the midrib. At the apex they curve slightly upwards, and at the base downwards.

The specimen figured on Plate X, fig. 2, is interesting, as showing what I take to be a young immature leaf of the same species. It measures 8 cm. in length, but neither the base nor the apex is seen. It has a maximum breadth of 1·5 cm. The apparently pointed termination above is deceptive. This portion of the leaf is in part folded on itself, and in part still covered by the rocky matrix. The nerves are slightly closer than in the previous specimen.

The photograph on Plate X, fig. 3, shows the base of a frond, and the long petiole. This specimen is in the British Museum collection (V. 11679). Another specimen in the same collection (V. 11671), figured on Plate IX, fig. 4, shows the apex of a frond, and the more acute origin of the lateral nerves in this region. On Plate X, fig. 5, part of another specimen (V. 11677) in the same collection is enlarged three times to show the nervation.

There are many other examples of this plant in the New Zealand Survey collection, some of which are of very large size. The fronds may be as much as 8 cm. broad, the stout midrib 1 cm. across, and there may be only 8 or 9 veins in 1 cm. of length of the lamina.

Remarks.—A comparison of the specimens seen on Plate X, fig. 1 and fig. 2, is interesting as showing how little the supposed distinctions founded solely on the size of the frond are to be depended upon, and consequently the absence of any real difference between *Macrotæniopteris* and *Tæniopteris.* The young leaves of the former would certainly be included in the latter genus.

The *Danæites Heerii* of de Zigno(1), from the Jurassic of Italy, closely resembles *Tæniopteris crassinervis* (Feist.), but I am not convinced that the two are identical. Fontaine(2) has also identified certain Tæniopterids from the Trias of Richmond in Virginia, U.S.A., as identical with the Indian plant, but the poor illustrations which he furnishes of these specimens do not suggest that these determinations are correct.

Occurrence.—Mataura Falls (Middle Jurassic).

3. Tæniopteris Daintreei McCoy. Plate VI, fig. 5.

1850. *Tæniopteris spatulata* McClelland, *Rep. Geol. Surv. India* for 1848–49, p. 53, pl. xvi, fig. 1.
1860. *Tæniopteris Daintreei* McCoy, *Trans. Roy. Soc. Victoria*, vol. 7, p. 97.
1863. *Stangerites spathulata* Oldham and Morris, *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. i, pt. i, p. 34, pl. vi, figs. 1–6.
1863. *Stangerites spathulata* var. *multinervis* Oldham and Morris, *ibid.*, p. 34, pl. vi, fig. 7.
1875. *Tæniopteris Daintreei* McCoy, *Pal. Victoria*, Dec. 2, p. 15, pl. xiv, figs. 1 2.
1877. *Angiopteridium spathulatum* Feistmantel, *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. i, pt. ii, pp. 45–107, pl. iv, figs. 1–7.
1877. *Angiopteridium spathulatum* Feistmantel, *ibid.*, vol. i, pt. iii, pp. 10–172, pl. 1, figs. 6*b*, 7*b*.
1878. *Tæinopteris Daentreei* Feistmantel, *Palæontogr.*, Suppl. iii, Lief. 3, Heft 1, p. 110, pl. 14, figs. 2, 3.
1879. *Angiopteridium spathulatum* Feistmantel, *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. i, pt. iv, pp. 16–206, pl. i, figs. 8–13, 17, 18; pl. ii, figs. 3, 5, 6; pl. xv, fig. 11.
1879. *Angiopteridium McClellandi* Feistmantel, *ibid.*, pp. 17–207, pl. i, figs. 14–16; pl. ii, fig. 4.
1890. *Tæniopteris Daintreei* Feistmantel, *Abhandl. k. böhm. Gesell. Wissen. (Math. Natur. Cl.)*, Folge vii, Bd. 3, No. 6, p. 66, pl. 2, fig. 11.
1890. *Tæniopteris Daintreei* Feistmantel, *Mem. Geol. Surv. N.S. Wales, Pal. No. 3*, p. 114, pl. xxvii, figs. 4, 5; pl. xxviii, figs. 6, 6*a*.
1892. *Tæniopteris Daintreei* McCoy, in Stirling, *Rep. Victorian Coalfields*, 1 and 2, p. 12, pl. ii, figs. 11, 12.
1898. *Angiopteridium spathulata* Dun, *Rep. Austral. Assoc. Adv. Sci., Sydney* p. 390.
1900. *Tæniopteris Daintreei* McCoy, in Stirling, *Rep. Victorian Coalfields No. 7*, p. 3, pl. i, fig. 5*b*; pl. ii, figs. 4, 7, 7*a*; pl. ii A.
1904. *Tæniopteris Daintreei* Seward, *Rec. Geol. Surv. Victoria*, vol. i, pt. iii, p. 168, pl. xiii, figs. 19, 20–22; pl. xiv, fig. 18; ? pl. xv, figs. 23, 24.

Diagnosis.—McCoy in 1875 (see above) gave the following diagnosis of this species: Frond very long, linear, parallel-sided; substance thick; edges straight; midrib thick, very strong; veins extending at right angles from the midrib to the lateral margins, a few straight and simple, the greater number once forked at a variable distance between the midrib and lateral margin. Usual width of frond, 4 lines; about 10 or 11 lateral veins in the space of 2 lines at the margin (both of ordinary specimens 4 lines wide, and one young fragment nearly 2 in. long, but only 1½ lines wide throughout).

Description of the Specimens.—*T. Daintreei* appears to be abundant in several localities in New Zealand. The specimen figured on Plate VI, fig. 5 (natural size), is from the Malvern Hills. It is a fragment of a narrow frond, 4 cm. long and about 1 cm. across. The midrib is stout, but the lateral nervation is not very clear.

Remarks.—This and other specimens appear to me to be quite similar to those figured from the Jurassic rocks of Victoria by Seward in 1904 as *T. Daintreei.*

Occurrence.—Clent Hills (Rhætic); McRae's, Makarewa, Hokonui Hills (? Rhætic); Hedgehope, Hokonui Hills (? Rhætic); Owaka Creek, Catlin's River (? Rhætic); Malvern Hills (? Lower Jurassic).

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(1) de Zigno (1856), p. 208, pl. xxv.

(2) Fontaine (1883), p. 22, pl. v, fig. 5; pl. vi, figs. 1, 2.

4. **Tæniopteris Thomsoniana** sp. nov. Plate VI, fig. 4; Plate VIII, figs. 4, 7.

1913. *Tæniopteris Daintreei* Arber, *Proc. Roy. Soc. London*, ser. B, vol. lxxxvi, p. 346, pl. viii, fig. 5.

Diagnosis.—Frond rather small, spathulate, broadest at apex, 3 cm. to 7 cm. or more in length, and up to 2 cm. broad. Apex broadly rounded. Median nerve fairly strong; lateral nerves fine, fairly close, arising at right angles to the median nerve, for the most part simple, but not infrequently forked near the midrib, and occasionally between the median nerve and the margin.

Description of the Specimens.—Two leaves from the Clent Hills are figured on Plate VIII, figs. 4 and 7, both natural size. A likewise incomplete leaf from Mount Potts is figured, twice enlarged, on Plate VI, fig. 4. This has a length of over 6 cm.

Remarks.—I have previously recorded this species as *Tæniopteris Daintreei* McCoy, but I am now of the opinion that it is a distinct species, which I propose to name *T. Thomsoniana*, in honour of Dr. J. Allan Thomson, F.G.S., of New Zealand. This species is particularly characterized by the relatively small size of the leaf, the spathulate form, and the comparatively infrequent dichotomy of the lateral nerves. Of the Australian Tænipoterids, it appears to approach nearest to *T. lentriculiforme* (Ether.)(1), which it somewhat resembles as regards the lateral nervation, though in the New Zealand plant the nerves appear to dichotomize more frequently. It is, however, distinguished by the form of the frond.

Type.—British Museum (Natural History).

Occurrence.—Mount Potts (Rhætic); Clent Hills (Rhætic).

5. **Tæniopteris vittata** Brongniart. Plate IV, fig. 4; Plate VI, figs. 2, 3.

1822. "Blattstuch einer Scitaminea" Sternberg, *Vers. Darstell. Flora Vorwelt*, Heft iii, p. 37, pl. xxxvii, fig. 2.
1828. *Tæniopteris vittata* Brongniart, *Prodr. Hist. Végét. Foss.*, p. 62.
1831–32. *Tæniopteris vittata* Brongniart, *Hist. Végét. Foss.*, p. 263, pl. lxxxii, figs. 1–4.
1829. *Scolopendrium solitarium* Phillips, *Geol. Yorks.*, 1st ed., p. 147, pl. viii, fig. 5.
1833. *Tæniopteris vittata* Lindley and Hutton, *Foss. Flora*, vol. i, pl. lxii.
1837. *Tæniopteris vittata* Lindley and Hutton, *ibid.*, vol. iii, pl. clxxvi B.
1865. *Tæniopteris vittata* Eichwald, *Leth. Ross.*, vol. ii, p. 24, pl. ii, fig. 5.
1869. *Oleandridium vittatum* Schimper, *Traité. Pal. Végét.*, vol. i, p. 607.
1873. *Tæniopteris vittata* Saporta, *Pal. Franç.*, vol. i, p. 444, pl. lxiv, figs. 1–5.
1875. *Tæniopteris vittata* Phillips, *Geol. Yorks.*, 3rd ed., p. 205, pl. viii, fig. 5.
1876. *Oleandridium vittatum* Feistmantel, *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. ii, pt. i, p. 15, pl. 1, fig. 5.
1876. Cf. *Tæniopteris mareyesiaca* Geinitz, *Palæontogr.*, Suppl. iii, Lief. ii (2), p. 9, pl. ii, figs. 1–3.
1887. Cf. *Oleandridium tenuinerve* Schenk, *Bibl. Bot.* (Uhlworm and Haenlein), Heft vi, p. 4, pl. v, fig. 20*a*.
1890. *Oleandridium vittatum* Schimper, in Zittel, *Handb. Pal.*, Abth. ii, Palæophyt., p. 133, fig. 107.
1897. *? Oleandridium vittatum* Bartholin, *Danmarks Geol. Undersög. 2 Raekke*, No. 7, p. 15, pl. —, fig. 8.
1900. *Tæniopteris vittata* Seward, *Jurass. Flora*, vol. i, p. 157, pl. xvi, fig. 1.
1910. *Tæniopteris spathulata* Krystofovic, *Mém. Com. Géol. St. Pétersbourg*, N.S., Livr. 56, p. 9, pl. ii, figs. 2, 2*a*.
1911. *Tæniopteris vittata* Thomas, *ibid.*, N.S., Livr. 71, pp. 23, 71, pl. iv. figs. 2, 3.
1911. *Tæniopteris vittata* Seward, *ibid.*, Livr. 75, pp. 16, 45, pl. iii, figs. 30, 31.

Diagnosis.—Leaf simple, broadly or narrowly linear, ribbon-shaped or elliptical, contracted somewhat at the base and apex, up to 20 cm. or more in length, and from 7 mm. to 3 cm. in width. Lateral nerves fine, close, arising at right

(1) Etheridge 1894[2]), p. 49, pl. viii.

angles to the midrib, simple or frequently forked either near the midrib or near the margin.

Description of the Specimens.—Several fragments of fronds of this species are seen, natural size, on Plate VI, figs. 2, 3. On Plate IV, fig. 4, another leaf is shown, somewhat contracted towards the base, and with a stout midrib. This, perhaps more than any of the other examples, resembles the British specimens of *Tæniopteris vittata.*

Remarks.—These specimens appear to me to be indistinguishable from those of *T. vittata* occurring in the Yorkshire Oolites. The form of the frond is perhaps a little more ribbon-shaped and less elongately elliptical than in the English fossils, though in the specimen shown on Plate IV, fig. 4, we have a type more attenuated at one extremity, like the British plants. I therefore do not attach any importance to such slight variations in the form of the frond. As regards the nervation, the New Zealand specimens appear to me to be identical with the British, in which, however, the nerves may be a little finer and closer.

Occurrence.—Curio Bay, Waikawa (Middle Jurassic).

Genus THINNFELDIA Ettingshausen, 1852.

(*Abh. k.k. Geol. Reichs.*, Bd. i, Abth. 3, No. 3, p. 2.)

Gothan(1) has recently proposed to remove three of the species from New Zealand here discussed to a new genus, *Dicroïdium*, as distinct from *Thinnfeldia.* The forking habit of the fronds of *T. odontopteroides*, *T. lancifolia*, and *T. Feistmanteli* is regarded as one point of dissimilarity, worthy of generic distinction. Others relate to certain features presented by cuticle preparations, especially the distribution of the stomata, and the presence or absence of subsidiary cells. As Antevs(2) has already pointed out, it is doubtful whether, as regards the latter points, there is any real distinction between these species and European members of the genus *Thinnfeldia.* So far as the branching of the frond is concerned, this feature does not appear to me of sufficient importance to warrant generic distinction, and I therefore prefer for the present to retain the well-established usage of referring the southern species to *Thinnfeldia*, to the members of which genus they are undoubtedly very similar in many respects.

1. Thinnfeldia sp., *cf.* T. argentinica (Geinitz). Plate I, fig. 9.

1876. *Otopteris argentinica* Geinitz, *Palæontogr.*, Suppl. iii, Lief. ii, (2) p. 6, pl. ii, figs. 5*a*, 5*b*.

Diagnosis.—Frond pinnate or (?) dichotomizing; pinnules thick, rhomboidal; nerves strong, arising independently from the rachis, and dichotomizing.

Description of the Specimen.—A fragment of a frond of *Thinnfeldia*, which is figured on Plate I, fig. 9, natural size, occurring in the New Zealand Geological Survey collection from the Clent Hills, shows several more or less rhomboidal pinnules, with strong dichotomizing nerves radiating from the base, and in most cases derived directly from the rachis. The pinnules appear to be somewhat thick and fleshy, and are contracted at the base.

Remarks.—The New Zealand specimen appears to agree fairly closely with Geinitz's species from Argentina, the chief difference being that in the latter the pinnules are distinctly rhomboidal in shape, though less so in the New Zealand fossil, where the angles are more rounded. The nervation appears, however, to be very similar in both

(1) Gothan (1912). (2) Antevs (1914).

specimens. On account of the slight difference in the shape of the pinnules, and especially in view of the fragmentary nature of the New Zealand fossil, I have been content simply to compare it with that described from Argentina.

Occurrence.—Clent Hills (Rhætic).

2. Thinnfeldia Feistmanteli ? (Gothan). Plate V, fig. 4.

1890. *Thinnfeldia odontopteroides* (pars) Feistmantel, *Mem. Geol. Surv. N.S. Wales, Pal. No. 3,* p. 101, pl. xxv.

1912. *Dicroïdium Feistmanteli* Gothan, *Abhandl. Naturhist. Gesellsch. Nürnberg,* vol. xix, p. 78, pl. xvi, fig. 1.

1913. *Dicroïdium Feistmanteli* Antevs, *K. svenska Vet.-Akad. Handl.,* vol. lii, No. 5, p. 1, pl. i, figs. 1–7.

1914. *Dicroïdium Feistmanteli* Antevs, *ibid.,* vol. li, No. 6, p. 52, pl. 1, figs. 5, 6; pl. 5, fig. 1.

Diagnosis.—Frond bipinnate above, dichotomous below; primary rachis stout; pinnæ lanceolate; pinnules large, unsymmetrically oval, approximated, confluent at the base especially towards the apex of the pinna. Nerves radiating from the base with frequent dichotomy.

Description of the Specimen.—Two pinnæ attached to a rachis are seen on Plate V, fig. 4, twice enlarged to show the nervation. The rachis is comparatively slender. The pinnæ measure 4 cm. or more in length, and the pinnules are unsymmetrically oval, and more or less united. There is no distinct midrib, the nerves all arising directly from the rachis and dichotomizing freely.

Remarks.—Gothan has recently distinguished one of the Australian specimens, assigned by Feistmantel in 1890 to *Thinnfeldia odontopteroides* (Morr.), as a new species, *Dicroïdium Feistmanteli* sp. This type is bipinnate above, and the pinnules are broader than in the ordinary forms of *T. odontopteroides.* It is difficult to decide whether it is really worthy of generic distinction or not, but, on the whole, I am inclined to accept *T. Feistmanteli* as a distinct species. In the present specimen the pinnules are thinner and less leathery than is usually the case in *T. odontopteroides,* but the rachis is much more slender than in the type specimen of *T. Feistmanteli,* and the pinnules are at the same time much smaller. I therefore regard the specific assignment of the New Zealand plant as somewhat doubtful.

Occurrence.—Owaka Creek, Catlin's River (? Rhætic); Curio Bay, Waikawa (Middle Jurassic).

3. Thinnfeldia lancifolia (Morris). Plate V, figs. 1, 2, (?) 6.

1845. *Pecopteris odontopteroides* var. *lancifolia* Morris, in Strzelecki, *Phys. Descr. N.S. Wales,* p. 249, pl. vi, fig. 4.

1888. *Thinnfeldia lancifolia* Szajnocha, *Sitzungsb. k. Akad. Wissen., Wien (Math.-Nat. Cl.),* vol. xcvii, p. 231, pl. i, figs. 4*b*, 5, 6, 7.

1909. *Thinnfeldia lancifolia* Dun, *Rec. Geol. Surv. N.S. Wales,* vol. viii, pt. iv, p. 316.

1912. *Dicroïdium lancifolia* Gothan, *Abhandl. naturhist. Gesell. Nürnberg,* vol. xix, p. 78, pl. xvi, figs. 2–4.

1913. *Thinnfeldia lancifolia* Arber, *Proc. Roy. Soc. London,* ser. B, vol. lxxxvi, p. 346, pl. viii, fig. 7.

1914. *Dicroïdium lancifolium* Antevs, *K. svenska Vet.-Akad. Handl.,* vol. li, No. 6, p. 58, pl. v, figs. 6, 7.

Diagnosis.—Habit as in *T. odontopteroides* (Morr.), (*q.v.*), but pinnules are elongate, bluntly lanceolate, decurrent, with a distinct midrib. The lateral nerves arise in part from the midrib, in part direct from the rachis, usually dichotomizing once, sometimes twice. Differs from *T. indica* Feistm. in the pinnules being neither contracted at the base nor acute at the apex.

Description of the Specimens.—Two fronds of this plant are figured on Plate V, figs. 1 and 2, the latter somewhat enlarged. Both show the actual dichotomy. The elongately lanceolate pinnules are only very slightly contracted at the base, as is well seen in both specimens. Another fragment is figured on fig. 6 of the same plate, twice enlarged.

Remarks.—This species of *Thinnfeldia* appears to be a rarer type than *T. odontopteroides,* and has been known hitherto only from Australia and South America.

Occurrence.—Mount Potts (Rhætic); McRae's, Makarewa, Hokonui Hills (? Rhætic); Owaka Creek, Catlin's River (? Rhætic).

4. Thinnfeldia odontopteroides (Morris). Plate I, fig. 7; Plate V, fig. 5.

1845. *Pecopteris odontopteroides* Morris, in Strzclecki, *Phys. Descrip. N.S. Wales and Van Diemen's Land*, p. 249, pl. vi, figs. 2–4.
1847. *Gleichenites odontopteroides* McCoy, *Ann. and Mag. Nat. Hist.*, vol. xx, p. 147.
1869. *Alethopteris ? odontopteroides* Schimper *Traité. Pal. Végét*, vol. i, p. 569.
1869. *Cycadopteris odontopteroides* Schimper, *ibid.*, p. 488.
1872. *Pecopteris odontopteroides* Carruthers, *Quart. Journ. Geol. Soc.*, vol. xxviii, p. 355, pl. xxvii, figs. 2, 3.
1875. *Pecopteris odontopteroides* Crépin, *Bull. Acad. Roy. Belgique*, ser. 2, vol. xxxix, p. 258, pl. —, figs. 1–5.
1876. *Thinnfeldia crassinervis* Geinitz, *Palæontogr.*, Suppl. iii, Lief. ii, p. 4, pl. 1, figs. 10–16.
1878–79. *Thinnfeldia (Pecopteris) odontopteroides* Feistmantel, *Palæontogr.*, Suppl. iii, Lief. iii, pp. 80, 169, pl. ix–xi; pl. xiii, fig. 5; pl. xiv, fig. 5; pl. xv, figs. 3–7; pl. xvi, fig. 1.
1881. *Thinnfeldia* cf. *odontopteroides* Feistmantel, *Foss. Flora Gondw. Syst. (Pal. Indica),* vol. iii, pt. 3, p. 85, pl. xxiii A, figs. 7–9.
1885. *Thinnfeldia odontopteroides* Curran, *Proc. Linn. Soc. N.S. Wales*, vol. ix for 1884, p. 252, pl. ix, fig. 4.
1888. *Pecopteris (Thinnfeldia) odontopteroides* Johnston, *Geol. Tasmania*, pl. xxv, figs, 1, 2, 4.
1888. *Thinnfeldia odontopteroides* Szajnocha, *Sitzungsb. k. Akad. Wissen. Wien (Math.-Nat. Cl.),* vol. xcvii, pt. 1, p. 228, pl. 1, figs. 1–3, 4*a*.
1890. *Thinnfeldia odontopteroides* Feistmantel, *Mem. Geol. Surv. N.S. Wales, Pal. No. 3,* p. 101, pl. xxiii–xxv; pl. xxvi, figs. 1, 2; pl. xxviii, fig. 8; pl. xxix, figs. 1–5.
1892. *Thinnfeldia odontopteroides* Jack and Etheridge, *Geol. & Palæont. Queensland,* p. 368, pl. xvii, fig. 1.
1898. *Thinnfeldia odontopteroides* var. *normalis,* Shirley, *Bull. 7, Geol. Surv. Queensland,* p. 21, pl. xi.
1902. *Thinnfeldia odontopteroides* Etheridge, in Brown, *Contrib. 12 & 13, Pal. South Australia,* p. 2, pl. i.
1902. *Thinnfeldia odontopteroides* Shirley, *Bull. 18, Geol. Surv. Queensland,* p. 11.
1902. *Thinnfeldia odontopteroides* Arber, *Quart. Journ. Geol. Soc.*, vol. lviii, p. 2.
1903. *Thinnfeldia odontopteroides* Seward, *Ann. S. African Mus.*, vol. iv. pt. 1, p. 52, pl. vii, figs. 1, 7, 8, 8*a*; pl. viii, figs. 7, 8; pl. ix, figs. 7, 8; pl. xi, fig. 2.
1908. *Thinnfeldia odontopteroides* Seward, *Quart. Journ. Geol. Soc.*, vol. lxiv, p. 92, pl. iv, fig. 1; pl. v, fig. 1; and text-figs. 3, 4.
1909. *Thinnfeldia odontopteroides* Dun, *Rec. Geol. Surv. N.S. Wales,* vol. viii, pt. iv, p. 315, pl. xlix, figs. 1, 2.
1912. *Dicroïdium odontopteroides* Gothan, *Abhandl. naturhist. Gesellsch. Nürnberg,* vol. xix, pt. iii, p. 78, pl. 15, fig. 4; pl. xvi, fig. 5.
1912. *Dicroïdium odontopteroides* Gothan, *ibid.*, vol. xix, pt. iv.
1914. *Dicroïdium odontopteroides* Antevs, *K. svenska Vet.-Akad. Handl.*, vol. li, No. 6, p. 55, pl. ii, figs. 2, 3; pl. iv, figs. 6, 7.

Diagnosis.—Fronds pinnate, frequently bifurcating into two equal approximated pinnæ. Rachis stout. Pinnules crowded, thick, very variable in form and in size, either broadly semicircular, deltoid, or oval, confluent at the base; nerves all arising directly from the rachis, and spreading throughout the lamina with dichotomy, or a more or less well-marked median nerve may be present, giving off forked lateral nerves at an acute angle.

Description of the Specimens.—The specimen from the Clent Hills, figured on Plate I, fig. 7, natural size, is quite the normal type of this species. The pinnules have a very broad base, and the nerves arise directly from the rachis. Several other examples occur in the collection, including forms with very short pinnules only 5 mm. long, and others with subcircular leaflets, like those from Owaka Creek shown on Plate V, fig. 5.

Remarks.—This fossil is one of the most characteristic plants of the Triassic rocks of the Southern Hemisphere, especially of Australia. It also occurs in South Africa and South America, and more rarely in India, in beds of the same age. In Europe and elsewhere other species of the same genus are commonly met with in the Rhætic and Liassic.

Occurrence.—Clent Hills (Rhætic), Owaka Creek, Catlin's River (? Rhætic).

Thinnfeldia sp. Plate II, fig. 11.

Description of the Specimen.—In Mr. Nicol's collection from Gore a specimen occurs of which a drawing is seen on Plate II, fig. 11. Several fragments of pinnæ are here shown. The left-hand example appears to me to recall *Thinnfeldia lancifolia* (Morris)(1), but most of the others appear to be lobed pinnules, showing various degrees of division. Unfortunately, all the leaves are too fragmentary to permit of specific determination.

Occurrence.—Mokoia, Gore (? Lower Jurassic).

Phylum CYCADOPHYTA.

Genus CYCADITES Sternberg, 1833.

(*Vers. Darstell. Flora Vorwelt,* Heft 5, 6, p. xxxii.)

Cycadites sp. Fig. 10.

Description of the Specimen.—A small fragment of a frond of *Cycadites* occurs in Professor Marshall's collection at Dunedin. The leaflets are narrow, and show in many cases the paired median nerves. It has not, however, been found possible to obtain preparations of the cuticle either in this or other specimens from New Zealand, since the preservation is not of the type necessary for this purpose. The fragment is too small to permit of specific determination. I refer it to *Cycadites* rather than to *Pseudocycas*, in accordance with Miss Holden's(2) conclusions on these genera.

Occurrence.—Curio Bay, Waikawa (Middle Jurassic).

Genus NILSSONIA Brongniart, 1824.

(*Am. Sci. Nat.* vol. iv, p. 10.)

1. Nilssonia compta ? (Phillips). Plate VIII, figs. 2, 3, 9.

1829. *Cycadites comptus* Phillips, *Geol. Yorks.*, 1st ed., p. 148, pl. vii, fig. 20.
1833. *Pterophyllum comptum* Lindley and Hutton, *Foss. Flora*, vol. i, pl. lxvi.
1863. *Pterophyllum princeps* Oldham and Morris, *Foss. Flora Gondwana Syst. (Pal. Indica)*, vol. i pt. i, p. 23, pl. x, figs. 1–3; pl. xi, figs. 1, 2; pl. xii, fig. 1; pl. xiii, figs. 1, 2.
1863. *Pterophyllum* sp. Oldham and Morris, *ibid.*, p. 25, pl. xii, figs. 2–5.
1864. *Pterophyllum comptum* Leckenby, *Quart. Journ. Geol. Soc.*, vol. xx, p. 77, pl. ix, fig. 1.
1875. *Pterophyllum comptum* Phillips, *Geol. Yorks.*, 3rd ed., p. 227, pl. vii, fig. 20.
1883. *Nilssonia compta* Schenk, in Richthofen's *China*, vol. iv, p. 262, pl. liv, fig. 2.
1900. *Nilssonia compta* Seward, *Jurass. Flora*, vol. i, p. 223, pl. iv, fig. 5; text-figs. 39, 40.
1911. *Nilssonia compta* Thomas, *Mém. Com. Géol. St. Pétersbourg*, N.S., Livr. 71, pp. 39, 85, pl. vi, fig. 3.

Diagnosis.—The following diagnosis was given by Seward in 1900 (see above): "Frond broadly linear; varying considerably in size, and in the depth, and number

(1) *Cf.* Szajnocha (1888¹), p. 231, pl. 1, figs. 4–6. (2) Holden (1914).

of the segments. The lamina is dissected up to the central midrib or rachis into truncate segments of unequal breadth, traversed by several parallel veins both simple and forked; the lamina is continuous over the rachis of the frond, and the segments are not laterally attached as in *Pterophyllum*."

Description of the Specimens.—A few fragments of a species of *Nilssonia* occur at Mokoia, Gore, three of which are figured on Plate VIII, figs. 2, 3, and 9, all natural size. That shown by fig. 3 measures nearly 4 cm. in length, and has a breadth of about 1 cm. The upper segment is not apical. The appearance of the frond here is due to the segments on either side of the midrib being imperfectly preserved. The segments are of unequal breadth, and truncated distally. The nervation is only faintly preserved, but most of the lateral nerves appear to be simple (*cf.* fig. 9). A short fragment similar to the last, showing the nerves more clearly, is shown by fig. 9 of the same plate. The unequal breadth of the segments is clearly seen here. A similar specimen is also seen in fig. 2.

Remarks.—It seems to me very probable that these specimens are simply small fronds of *Nilssonia compta* (Phill.), similar to those figured by Oldham and Morris(1) and by Seward(2).

Occurrence.—Mokoia, Gore (? Lower Jurassic).

2. **Nilssonia elegans** sp. nov. Plate VIII, fig. 8; Plate IX, figs. 1, 3.

Diagnosis.—Leaf up to 9–10 cm. in length, and from 2 mm. to 10 mm. broad; midrib strong, 1·5 mm. across; lamina very narrow, entire or lobed or divided to the midrib; lobes of unequal size, more or less rectangular; apex subacute or bluntly pointed.

Description of Specimens.—An undivided frond, about 9 cm. long, but only 7 mm. across at its broadest part, is seen on Plate IX, fig. 1, natural size. It apparently has an acute apex. The nervation is not seen in this specimen. Another incomplete specimen, 5 cm. long, with a more or less deeply lobed lamina, is shown twice enlarged on Plate IX, fig. 3. The nerves are here faintly seen. They are fine, parallel, and somewhat distant, and no doubt occasionally fork. The narrower leaves, which are seen scattered about on the same specimen, appear to be either young fronds of this species in which the lamina is very narrow, or the long basal portions of leaves.

A drawing of a group of three leaves is shown on Plate VIII, fig. 8. These are similar to those just described. The lobes or divisions are very irregular in size, and are truncated distally. Here again the nervation is only very faintly preserved.

Remarks.—This plant has something in common, as regards habit, with *Nilssonia polymorpha* Schenk(3), a much larger plant, quite distinct specifically, but showing equally transitions from the simple to a compound leaf. It does not agree with any of the species recently figured by Nathorst(4).

Type.—New Zealand Geological Survey collection.

Occurrence.—Mataura Falls, Southland (Middle Jurassic).

Genus PTEROPHYLLUM Brongniart, 1824.

(*Ann. Sci. Nat.*, ser. i, vol. iv, p. 211.)

Pterophyllum matauriensis Hector. Plate IX, fig. 2; Plate XII, fig. 1.

1886. *Pterophyllum matauriensis* Hector, *Det. Cat. & Guide, N. Zeal. Court, Ind. & Col. Exhib.*, p. 66, text-fig. 30*a*(7).

Diagnosis.—Pinnate fronds, up to 11 cm. in length. Rachis stout, up to 2·5 mm. across, grooved; pinnæ attached at the side of the rachis; alternate, or more rarely subopposite, 2·5 cm. to 3 cm. in length, broadest near the point of attachment, up

(1) Oldham and Morris (1863), pl. xii, figs. 2–5.
(2) Seward (1900), text-fig. 39 on p. 225.
(3) Schenk (1867), p. 127, pl. xxix; pl. xxx, figs. 1–5; pl. xxxi, figs. 1*a*, 1*b*, 1*c*.
(4) Nathorst (1909).

to 4 mm. to 6 mm. in width at greatest breadth, more or less lanceolate, gradually tapering to an obtuse bluntly rounded apex. Veins parallel, 5 or more in each pinnule near the base, occasionally forking.

Description of the Specimens.—Two specimens from Mataura Falls are figured. Fig. 1 (natural size), Plate XII, shows the general habit, and fig. 2, Plate XVIII, is an enlarged photograph of another specimen, showing the bases of the pinnules and their nervation. Hector's figure (see above) is quite inaccurate as regards the apical characters of the leaflets, which are shown as if they were extremely acute, whereas in reality they are bluntly rounded.

Remarks.—Hector's plant is, I believe, a distinct type, not previously described. Its nearest affinities appear to be *Pterophyllum Sandbergeri* Schenk(1), from the Keuper of Raibl, Austria, and *P. Münsteri* Schenk(2), from the Rhætic of Germany. There are, of course, many other species from Rhætic or Jurassic beds in various parts of the world with which more remote comparisons might be instituted.

Type.—New Zealand Geological Survey collection.

Occurrence.—Mataura Falls, Southland (Middle Jurassic).

Genus PTILOPHYLLUM Morris, 1840.

(*Trans. Geol. Soc.*, ser. 2, vol. v, p. 327.)

1. **Ptilophyllum acutifolium** Morris. Plate XI, figs. 1, 2, 5.

1840. *Ptilophyllum acutifolium* Morris, *Trans. Geol. Soc.*, ser. 2, vol. v, p. 327, pl. xxi, figs. 1–3.
1841. *Ptilophyllum acutifolium* Morris, *Ann. & Mag. Nat. Hist.*, vol. vii, p. 117.
1850. *Zamia Theobaldii* McClelland, *Rep. Geol. Surv. India*, for 1848–49, p. 52, pl. xii, figs. 1, 2.
1863. *Palæozamia acutifolium* Oldham and Morris, *Foss. Flora Gondwana Syst. (Pal. Indica)*, vol. i, pt. i, p. 29, pl. xx, figs. 1, 2; pl. xxi, fig. 2.
1863. *Palæozamia acutifolium* var. *conferta* Oldham and Morris, *ibid.*, p. 29, pl. xx, fig. 3.
1867. *Palæozamia acutifolium* Blandford, *Mem. Geol. Surv. India*, vol. vi, pp. 9, 16.
1870–72. *Ptilophyllum acutifolium* Schimper, *Traité Pal. Végét.*, vol. ii, p. 166.
1872. *Palæozamia acutifolia* Wynne, *Mem. Geol. Surv. India*, vol. ix, p. 173.
1876. *Ptilophyllum acutifolium* Feistmantel, *Foss. Flora Gondwana Syst. (Pal. Indica)*, vol. ii, pt. i, p. 44, pl. v, figs. 4, 4*a*.
1877. *Ptilophyllum (Palæozamia) acutifolium* Feistmantel, *Palæontogr.*, Suppl. iii, Lief. iii, p. 11, pl. i; pl. ii; pl. iii, figs. 1, 2.
1877. *Ptilophyllum acutifolium* Feistmantel, *Foss. Flora Gondwana Syst. (Pal. Indica)*, vol. i, pt. ii, pp. 65–117, pl. xl.
1877. *Ptilophyllum acutifolium* Feistmantel, *ibid.*, vol. i, pt. iii, pp. 178–216, pl. ii, figs. 1, 2, 4.
1877. *Ptilophyllum acutifolium* Feistmantel, *ibid.*, vol. ii, pt. ii, pp. 94–114; pl. v; pl. vi, fig. 2.
1879. *Ptilophyllum acutifolium* Feistmantel, *ibid.*, vol. i, pt. iv., pp. 23–213, pl. x, figs. 1–3, 7–9; pl. xi, fig. 1; pl. xv, figs. 12, 13; pl. xvi, fig. 14.
1913. *Ptilophyllum acutifolium* Halle, *K. svenska Vet.-Akad. Handl.*, vol. li, No. 3, p. 34, pl. iii, figs. 1–12.

Diagnosis.—Leaf pinnate, elongately lanceolate, exceeding 15 cm. in length and 1·5 cm. in breadth. Pinnules 1–4 cm. in length, and 3 mm. across at the base, approximated, alternate, elongately lanceolate, broadest at the base, straight or more usually falcate, apex acuminate, base unsymmetrical, upper margin auriculate, rounded, lower margin straight. Nerves about 5, arising from the rachis, and usually forking once, subparallel, radiating from the base.

Description of the Specimens.—The specimen seen on Plate XI, fig. 5, natural size, shows several fragments of these leaves. A single leaf occurring on the back of the

(1) Schenk (1866), p. 17, pl. i, fig. 9. (2) Schenk (1867), p. 167, pl. xxxix, figs. 1–3.

same specimen is seen on the same plate (fig. 2). It measures nearly 12 cm. in length. The form of the bases of the pinnules, and the acute apices, are well seen. Part of another leaf is figured, three times enlarged, on Plate XI, fig. 1, to show the nervation.

Remarks.—This plant is abundant at Waikawa. The pinnules of the leaves are not so long as those from India figured by Oldham and Morris, but correspond more closely with their variety "*conferta*" (see above). They are also shorter than the majority of Feistmantel's specimens, though that author has also figured(1) several short-pinnuled leaves, with which the New Zealand specimens may be compared.

The resemblance to the Wealden fronds from Patagonia recently figured by Halle(2) is still more remote. No doubt great variations are met with in the fronds of this species.

Seward(3) has concluded that *Ptilophyllum acutifolium* is identical with *Williamsonia pecten* (Phill.). I am not, however, convinced as to the specific identity, though no doubt, generically, the two plants are closely allied.

Occurrence.—Curio Bay, Waikawa (Middle Jurassic).

Stem of (?) Ptilophyllum sp. Plate XII, fig. 5.

Description of the Specimen.—The stem structure seen on Plate XII, fig. 5, natural size, is associated with leaves of *Ptilophyllum acutifolium* at Waikawa, and may possibly be the stem of that plant. It has a highly branched axis, three branches being seen in the figure—one a comparatively long one on the left-hand side, and two short lengths of branches below on the right. These axes show, however, no definite scars or other surface features, and they are probably decorticated. Fragments of petioles, which resemble the bases of the leaves of *Ptilophyllum acutifolium*, are apparently attached to the main branches, but actual continuity between the stem and the leaves cannot be demonstrated. The evidence of association is, however, in this case fairly strong in support of the provisional view that this specimen may be the stem of *Ptilophyllum acutifolium* Morr.

Remarks.—This specimen somewhat recalls in appearance a badly preserved decorticated stem of *Williamsonia* in the Sedgwick Museum, Cambridge.

Pinnule of a Cycadophyte. Plate VII, fig. 7.

Remarks on the Specimen.—A single pinnule of a frond of a Cycadophyte, perhaps a *Pterophyllum*, occurs in the Mokoia beds near Gore. This is figured, natural size, on Plate VII, fig. 7. The pinnule is narrow, and has six parallel nerves, but unfortunately it is too fragmentary for even generic determination.

Phylum PODOZAMITEÆ.

Genus PODOZAMITES Braun, 1843.

(In Münster, *Beitr. Petrifact.*, Heft vi, p. 28.)

Podozamites gracilis sp. nov. Figs. 11, 12.

Diagnosis.—Shoots exceeding 20 cm. in length. Leaves spirally arranged, linear-lanceolate, up to 6 cm. in length, and 4 mm. to 5 mm. broad at their greatest width. Base gradually contracted, but not decurrent, apex acuminate. Nerves about 5 to 7 in number, parallel.

(1) Feistmantel (1876[1]), pl. v, fig. 4; (1876[2]), pl. i, figs. 2, 3; (1877[3]), pl. v. fig. 5; (1879[2]) pl. x, fig. 3; pl. xv, figs. 12, 13.

(2) Halle (1913[2]), p. 34, pl. iii, figs. 1–12.

(3) Seward (1900), p. 193; (1904[2]), p. 108.

Description of the Specimens.—There are several specimens in the New Zealand Survey collections from Waikawa, which appear to represent a new species of *Podozamites.* None of these, however, are at all perfect. A photograph of one, showing the general habit of the leafy shoot, is reproduced, natural size, as fig. 11. Fig. 12 is a drawing of another example, in which the individual leaves attached to the stem are seen more clearly.

Remarks.—This plant appears to be a very distinct species, characterized by the narrow linear leaves. In the British Jurassic type, *Podozamites lanceolatus* (L. & H.), the leaves are much broader and more lanceolate in form. In the common Rhætic species of Australia, *P. elongatus* (Morr.), the leaves are also broader and more elongated.

In 1868 Eichwald(1) figured a leaf from the Jurassic of Russia under the name *Zamites angustifolius* sp. nov. Judged by his figure, this specimen is probably more correctly assigned to *Zamites* than to *Podozamites,* to which, however both Heer and Schimper(2) have referred it. The base of the leaf is clearly decurrent, and the general habit is much more like that of a Cycadean frond than of a shoot bearing spirally arranged leaves. Heer(3) has, however, referred some further plants from Siberia to Eichwald's species, as *Podozamites angustifolius* (Eichw.). Some of these approach *Podozamites gracilis* somewhat closely, though the leaves appear to be shorter and rather different in shape.

Type.—New Zealand Geological Survey collection.

Occurrence.—Curio Bay, Waikawa (Middle Jurassic).

Fig. 12. Podozamites gracilis sp. nov., from Waikawa.

In the New Zealand Geological Survey Collection. Natural size.

(1) Eichwald (1863), vol. ii, p. 39, pl. 2, fig. 7.
(2) Schimper (1869), vol. ii, p. 160.
(3) Heer (1876^{2}), pl. 45, pl. xxvi, fig. 11; (1878), p. 22, p . v, figs. 11*b*, 12.

Phylum GINKGOALES.

Genus BAIERA Braun, 1843.

(In Münster's *Beitr. Petrifact.*, Heft vi, p. 20.)

Baiera robusta sp. nov. Plate XI, figs. 3, 4.

1913. *Baiera* cf. *B. paucipartita* Arber, *Proc. Roy. Soc.*, ser. B, vol. lxxxvi, p. 346, pl. vii, figs. 1, 2, 3.

Diagnosis.—Leaves exceeding 4 cm. in length, of varying breadth, slit longitudinally for at least half their length into narrow segments of unequal breadth. Base broad, not markedly contracted, usually 6 or more parallel nerves in each segment.

Description of the Specimens. — The two specimens from Mount Potts, which I originally figured in 1913 as *Baiera* cf. *B. paucipartita*, are refigured on Plate XI, figs. 3 and 4. The former is a forked segment, shown nearly twice enlarged, but is incomplete at both extremities. The latter, which is natural size, shows the median part of a leaf split into four segments of unequal breadth.

Remarks.—There are several Rhætic species with which the New Zealand fossils may be compared. First we have the *Baiera paucipartita* of Nathorst(1), from Sweden, in which the base of the leaf is markedly contracted. This I now believe to be a distinct species, though in some respects it stands near to *B. robusta.* The *Baiera multifida* of Fontaine(2), from the Rhætic of Virginia, in the United States, and from Australia(3), appears to be a much larger leaf, judging by the very imperfect figures given of this plant. The segments of this species, however, may be compared with the New Zealand specimen. Other species which may be also compared are *Baiera tæniata* Braun(4), from the Rhætic of Germany, and *B. sub-gracilis* McCoy(5), from the Jurassic of Victoria, Australia.

Type in British Museum (Natural History).

Occurrence.—Mount Potts (Rhætic).

Phylum CONIFERALES.

Genus ARAUCARITES Presl, 1838.

(In Sternberg, "*Vers. Darstell. Flora Vorwelt,*" Heft. vii, p. 203.)

Araucarites cutchensis Feistmantel. Plate VIII, fig. 5; Plate XIII, fig. 4.

1876. *Araucarites cutchensis* Feistmantel, *Foss. Flora Gondwana Syst. (Pal Indica)*, vol. ii, pt. i, p. 62, pl. vii, fig. 7; pl. viii, figs. 2–6; pl. ix, figs. 1–3; pl. xii, fig. 10.
1877. *Araucarites cutchensis* Feistmantel, *ibid.*, vol. ii, pt. ii, pp. 16–96, pl. xiv.
1879. *Araucarites cutchensis* Feistmantel, *ibid.*, vol. i, pt. iv, pp. 27–217, pl. xiv, figs. 6–9; pl. xv, fig. 1; pl. xvi, fig. 15.
1913. *Araucarites cutchensis* Halle, *Wissen. Ergeb. Schwed. Südpolar-Exped.*, vol. iii, pt. xiv, p. 72, pl. viii, figs. 3–10, text-fig. 16.

Diagnosis.—Seed-bearing scales of the Araucarian type. Scales more or less broadly wedge-shaped, the base narrow, truncated, the apex broad, rounded, or truncated, often produced as a median narrow linear appendage. Seed single, ovoid, the broader extremity being towards the apex of the scale.

Description of the Specimens.—Two Araucarian scales occur at Gore, of which one is figured, natural size, on Plate XIII, fig. 4. In this photograph the appearance is

(1) Nathorst (1878 2), p. 94, pl. xx, figs. 7–13; pl. xxi; pl. xxii, figs. 1, 2.
(2) Fontaine (1883), p. 87, pl. xlv, fig. 3; pl xlvi, figs. 1–3; pl. xlvii, figs. 1, 2.
(3) Arber, 1902), p. 4.
(4) Schenk (1867), p. 26, pl. v, figs. 1–4; pl. vi, figs. 1, 2.
(5) McCoy (1900), p. 5, pl. 1, figs. 4, 6, 7.

that of the reverse of the original(1), as will be seen by a comparison of Plate VIII, fig. 5, which is a drawing of the same scale, enlarged one and a half times. The specimen measures 2·1 cm. in length, and 1·5 cm. across at its widest part. The shape is ovate. In the centre there is an elongately elliptical hollow, that no doubt marks the place of attachment of the seed, which, however, is absent.

Remarks.—These scales agree very closely with those figured by Feistmantel(2) from the Jabalpur group of India.

Occurrence.—(?) Mount Potts, Canterbury (Rhætic); Mokoia, Gore, Southland (? Lower Jurassic).

Genus BRACHYPHYLLUM Brongniart, 1849.

(*Tabl. Genr. Végét. Foss.*, p. 69.)

Brachyphyllum sp. Plate XIII, figs. 8, 10.

Description of the Specimens.—Several examples of indifferently preserved Coniferous branches occur in the Catlin's River beds, densely clothed with short, triangular, somewhat fleshy leaves, spirally arranged. One of these twigs is shown on Plate XIII, fig. 8, natural size. Another, a branched specimen, is illustrated, twice enlarged, by fig. 10 of the same plate.

Remarks.—The preservation of these specimens is in no case good enough to warrant specific determination. They may be compared, however, with the Rhætic plants referred to this genus by Schenk(3) in Germany, and also with the English specimens(4) of like affinity from the Yorkshire Oolites. As compared with the Australian species there is some resemblance to the obscure *Brachyphyllum crassum* of Tenison-Woods(5), but less so to the *Brachyphyllum gippslandicum* of McCoy(6), which has more oval or elliptical leaves.

Occurrence.—Owaka Creek, Catlin's River, Otago (? Rhætic).

Genus CRYPTOMERITES Bunbury, 1851.

(*Quart. Journ. Geol. Soc.*, vol. vii, p. 190.)

Cryptomerites sp.

Remarks.—In the New Zealand Geological Survey collection are two very indistinct examples of Coniferous twigs from Makarewa, which resemble in habit the *Cryptomerites divaricatus* of Bunbury(7), with the type of which, at Cambridge, I have compared them. Bunbury's plant is from the Lower Oolite of the Yorkshire coast. The New Zealand specimens, however, are too badly preserved to permit of any scientific comparison. They may, however, be also compared, as regards the genus, with the India Gondwana specimen from Cutch, figured by Feistmantel(8) under Bunbury's name, and a specimen from the Jurassic of Grahamland, referred to the genus *Pagiophyllum* by Halle(9).

Occurrence.—McRae's, Makarewa, Hokonui Hills, Southland (? Rhætic).

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(1) Presumably owing to the photographic plate having been inserted in the camera in the wrong position.
(2) Feistmantel (1877[3]), pp. 16 96, pl. xiv.
(3) Schenk (1867), p. 187, pl. 159, pl. 5.
(4) Seward (1900), p. 297, pl. x, fig. 1.
(5) Tenison-Woods (1883), p. xliii.
(6) McCoy (1900), p. 5, pl. ii, figs. 1, 2, 5, 5*a*; pl. iii, figs. 10–16.
(7) Bunbury (1851), p. 190, pl. xiii, fig. 4; see also Seward (1900), p. 287.
(8) Feistmantel (1876[1]), vol. ii, pt. 1, p. 59, pl. x, figs. 1, 1*a*.
(9) Halle (1913[1]), p. 74, pl. viii, fig. 11.

Genus ELATOCLADUS Halle, 1913.

(*Wissensch. Ergeb. Schwed. Südpolar-Exped.*, vol. iii, pt. xiv, p. 82.)

Dr. Halle(1) has recently proposed the term *Elatocladus* for "sterile Coniferous branches of the radial or the dorsi-ventral type, which do not show any characters which permit them to be included in one of the genera instituted for more peculiar forms." It is a common experience, when dealing with Mesozoic Conifers, to find difficulty in deciding as to which genus certain sterile shoots should be referred, the genera in question being chiefly characterized by the form of their cones. In other words, one can among these sterile shoots easily determine the species, whereas the generic attribution is a matter of greater difficulty. Dr. Halle's suggestion is that in such cases one should not attempt, in the absence of the cones, to refer the fossils to such genera as *Palissya*, *Taxites*, &c., but place them in a special genus *Elatocladus*. This suggestion is a good one, and will be adopted here.

1. Elatocladus conferta (Oldham and Morris). Plate I, figs. 1, 3; Plate VI, fig. 4; Plate VIII, fig. 6.

1863. *Cunninghamites confertus* Oldham and Morris, *Foss. Flora Gondw. System (Pal. Indica)*, vol. i, pt. i, pl. xxxii, fig. 10.

1877. *Palissya conferta* Feistmantel, *ibid.*, vol. i, pt. ii, pp. 85–137, pl. xlv, figs. 4–8; pl. xlviii, fig. 4.

1877. *Palissya conferta* Feistmantel, *ibid.*, vol. i, pt. iii, pp. 21–183, pl. v, fig. 3; pl. viii, figs. 1–6.

1879. *Palissya conferta* Feistmantel, *ibid.*, vol. i, pt. iv, pp. 216–26, pl. xiv, fig. 3; pl. xv, fig. 14.

1900. *Palissya australis* McCoy, in Stirling, *Rep. on Victorian Coalfields, No. 7*, p. 6, pl. iii, figs. 8, 9.

1913. *Palissya conferta* Arber, *Proc. Roy. Soc. London*, ser. B, vol. lxxxvi, p. 346, pl. viii, fig. 5.

1913. *Elatocladus conferta* Halle, *Wissen. Ergeb. Schwed. Südpolar-Exped.*, vol. iii, Lief. 14, p. 86, pl. viii, figs. 26–40.

Diagnosis.—Shoots freely branched, branches with dorsi-ventral symmetry, arising at a wide angle. Leaves spirally arranged, but twisted into two rows, falsely distichous, sessile, decurrent, usually making a very open angle with the axis. Lamina oblong-linear, about 6 mm. long and 1 mm. across, slightly contracted at the base, uninerved; apex obtuse.

Description of the Specimens.—*Elatocladus conferta* (O. & M.) appears to be widely distributed in New Zealand, and is a very variable type. A branched specimen from the Rhætic of Mount Potts is figured, twice enlarged, on Plate VI, fig. 4, associated with *Tæniopteris Thomsoniana*. This appears to be identical with the Indian Gondwana specimens, and also with those recently figured from Grahamland by Halle.

A drawing of similarly branched fragments from the Clent Hills is shown on Plate I, fig. 1, natural size.

Another specimen from the Jurassic of the Malvern Hills is seen, natural size, on the same plate, fig. 3. The leaves here are distinctly broader than in the previous examples. This type is, however, known elsewhere, and has been included under *E. conferta* by both Feistmantel and Halle(2). These specimens very closely resemble some described from the Jurassic rocks of India by Feistmantel(3) in 1877. A drawing of a fragment of a leafy shoot from Gore is reproduced on Plate VIII, fig. 6, natural size.

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(1) Halle (1913[1]), p. 83.
(2) Halle (1913[1]), pl. viii, fig. 35.
(3) Feistmantel (1877[2]), pl. viii, figs. 1–6.

Remarks.—These specimens may be compared with *Stachyotaxus septentrionalis* (Agardh), from the Rhætic of Greenland(1) and Sweden(2).

Elatocladus conferta appears to be a widely distributed type, occurring in India, Australia, New Zealand, and Grahamland.

Occurrence.—Mount Potts, Canterbury (Rhætic); Clent Hills, Canterbury (Rhætic); Malvern Hills, Canterbury (? Lower Jurassic); Mokoia, Gore, Southland (Middle Jurassic); Curio Bay, Waikawa, Southland (Middle Jurassic).

2. Elatocladus sp. Plate XIII, fig. 9.

Description of the Specimen.—The New Zealand Geological Survey collection from Waikawa contains a single example of a species of *Elatocladus* with longer leaflets. These exceed 1·5 cm. in length, and are uninerved. This specimen is shown enlarged on Plate XIII, fig. 9. Unfortunately, it is not only fragmentary but poorly preserved, and it appears to be impossible to determine it specifically.

Remarks.—This specimen may, however, be compared with *Palissya indica* (Old. & Morr.)(3), and, so far as I can judge, it is certainly Coniferous, and not a Cycadophytean frond(4). It also somewhat resembles the Coniferous remains from the Rhætic of Sweden, described by Nathorst as *Palæotaxus rediviva* Nath.(5).

Occurrence.—Waikawa, Southland (Middle Jurassic).

Genus NAGEIOPSIS Fontaine, 1889.

(*Monogr. U.S. Geol. Surv.*, vol. xv, p. 194.)

Nageiopsis longifolia (?) Fontaine. Plate VII, figs. 1, 2.

1889. *Nageiopsis longifolia* Fontaine, *Monogr. xv, U.S. Geol. Surv.*, p. 195, pl. lxxv, fig. 1; pl. lxxvi, figs. 2–6; pl. lxxvii, figs. 1, 2; pl. lxxviii, figs. 1–5; pl. lxxix, fig. 7; pl. lxxxv, figs. 1, 2, 8, 9.

1889. *Nageiopsis crassicaulis* Fontaine, *ibid.*, p. 198, pl. lxxix, figs. 2, 6; pl. lxxxii, fig. 1 pl. lxxxiv, figs. 3, 9, 11.

1905. *Nageiopsis longifolia* Ward, *Monogr. xlviii, U.S. Geol. Surv.*, p. 259, &c., pl. lxviii, figs. 9, 12; pl. lxxiii, fig. 9.

1911. *Nageiopsis longifolia* Berry, *Maryland Geol. Surv., Lower Cretac.*, p. 384, pl. lxi.

Diagnosis.—The following is the diagnosis given by Berry in 1911: "Branching leafy twigs of large size, stout and thick, apparently branched in approximately one plane. Leaves linear-lanceolate, often slightly curved, somewhat equilaterally narrowed into a short slightly twisted petiole; above, gradually narrowed to the acute or subacute tip. Length, 8 cm. to 20 cm.; width, 5 mm. to 1·3 cm. The leaves are not crowded, and usually appear opposite or subopposite as if inserted on the lateral margins of the stem, although at times they seem to be attached to its upper or lower side. As previously remarked, none of the material is conclusive in regard to the phyllotaxy. Veins 9 to 12 in number, usually 10, forking only at the base and running parallel until they abut against the leaf-margin, about 0·7 mm. apart, somewhat coarser in calibre than in the other members of the genus, distinct on both sides of the lamina, and apparently not immersed. Leaf-substance not coriaceous."

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(1) Hartz (1896), p. 242, pl. xiii, fig. 4*a*; pl. xix, figs. 2–4.

(2) Nathorst (1908), p. 11, pl. ii, fig. 28; pl. iii, figs. 1–9.

(3) Oldham and Morris (1863), pl. xxxiii, fig. 6.

(4) *Cf.* especially Feistmantel (1876[1]), pl. xi, fig. 5, described as *Cycadites cutchensis* Feist., and (1879), pl. xiv, figs. 1, 4, 5 (*Taxites planus* Feist.).

(5) Nathorst (1908), pl. iii, figs. 13–17.

Description of the Specimens.—The imperfect specimen seen on Plate VII, fig. 1, enlarged $\frac{3}{2}$, shows a fairly broad axis with several narrow leaves, four of which at least are attached. The leaves appear to be opposite or subopposite, and somewhat contracted at the base. All are imperfect, but their length exceeds 3·5 cm. The breadth is about 5 mm., and the nerves are close and parallel, about 8 or more in number.

Another specimen in the British Museum collection is shown, natural size, on Plate VII, fig. 2. The axis here is less stout, being 2·5 mm. across. Three leaves are attached, which exceed 1·5 cm. in length, and are 5·5 mm. broad. The attachment here appears to be spiral. The nerves are more than 8 in number in each leaf.

Remarks.—In the stout axis and the subopposite insertion of the leaves, the larger of these specimens may be compared to members of the genus *Nageiopsis* Font. In other respects the habit is very similar to *Podozamites lanceolatus* (L. & H.).

It is doubtful whether either specimen is sufficiently perfect to admit of specific determination. In referring them provisionally to *N. longifolia* (Font.), I at the same time admit the possibility that they may stand nearer to Fontaine's *N. angustifolia*(1). There is also some similarity to Fontaine's(2) *Podozamites Emmonsi*, which also has a broad axis, though here the leaves are spirally arranged.

Occurrence.—Waikato Heads, Auckland (Neocomian).

Genus PAGIOPHYLLUM Heer, 1881.

(*Sect. Trav. Géol. Portugal*, p. 11.)

Pagiophyllum peregrinum (Lindley and Hutton). Plate XIII, fig. 1.

1833. *Araucaria peregrina* Lindley and Hutton, *Fossil Flora*, vol. ii, pl. lxxxviii.
1846. *Araucaria peregrina* Kurr, *Beitr. Foss. Flora Juras. Württembergs*, p. 9, pl. 1, fig. 1.
1858. *Araucaria peregrina*, Quenstedt, *Der Jura*, p. 272, pl. xxxix, figs. 1–3.
1870. *Pachyphyllum peregrinum* Schimper, *Traité Pal. Végét.*, vol. ii, p. 250.
1879. *Pachyphyllum peregrinum* Feistmantel, *Foss. Flora Gondwana Syst. (Pal. Indica)*, vol. i, pt. iv, pp. 28–218, pl. xi, fig. 5; pl. xii, figs. 3, 9.
1884. *Pachyphyllum peregrinum* Saporta, *Plant. Jurass.*, vol. iii, pp. 383, 653. pl. 173, figs. 9, 10; pl. 174; pl. 175, figs. 1, 2; pl. 176, figs. 1–3; pl. 225, figs. 3, 4.
1886. *Taxites manawao* Hector, *Det. Cat. & Guide, N. Zeal. Court, Ind. & Col. Exhib.*, p. 66, fig. 30*a*(6).
1894 *Pachyphyllum liasinum* Saporta, *Flor. Foss. Portugal*, p. 7, pl. i, fig. 17; pl. ii, fig. 1.
1900. *Pagiophyllum peregrinum* Ward, *20th Ann. Rep. U.S. Geol. Surv.*, p. 308, pl. xlv.
1904. *Pagiophyllum peregrinum* Seward(3), *Jurassic Flora*, vol. ii, p. 48, pl. v.
1906. *Pagiophyllum peregrinum* Zeiller, *Flore Foss. Bass. Houill. et Perm. Blanzy & Creusot*, p. 219, pl. li, figs. 2, 3.

Diagnosis.—The following are the characters of this species, as given by Seward(4): "Vegetative shoots monopodially branched, bearing crowded, spirally disposed, fleshy leaves. The leaves vary in shape and position; they are usually broadly triangular, sometimes reaching a length of 5 mm., imbricate and fairly closely appressed to the stem; in some shoots they are more open in arrangement and more distinctly falcate. The back of the leaves bears a broad median keel, and the lamina is frequently characterized by numerous longitudinal striations or wrinklings; the apex of the leaf may be obtuse or acuminate."

Description of the Specimens.—The specimen figured by Hector in 1886 (see above) is refigured on Plate XIII, fig. 1. Its greatest length is 7·5 cm. Four branches are seen,

(1) See Berry (1911), p. 389, pl. lxiii, figs. 3, 4.
(2) Fontaine (1883), p. 77, pl. xxiii, fig. 2.
(3) This work contains a full synonymy of this species.
(4) Seward (1904²), p. 49.

each clothed with the characteristic thick, fleshy, triangular leaves, closely imbricated, and these appear to me to be identical with those of British examples of this plant.

Remarks.—Zeiller (see above) has recently figured the cuticles and stomata of this plant.

Occurrence.—Mataura Falls, Southland (Middle Jurassic).

Genus STACHYOTAXUS Nathorst, 1886.

(*Floran vid Bjuf*, p. 98.)

Stachyotaxus (?) sp. Plate XIII, fig. 7.

Description of the Specimen.—Fructifications which appear to have some resemblance to Nathorst's(1) *Stachyotaxus* occur at Gore, but unfortunately none of them are sufficiently well preserved to be specifically determinable. One of these is seen on Plate XIII, fig. 7, somewhat enlarged. It measures 9 cm. in length. It consists of a broad axis bearing a large number of oval, stalked bodies, the exact nature of which it is impossible to determine, though if the resemblance to *Stachyotaxus* is a real one they are probably in some cases seeds borne on scales, and scales alone in others.

Remarks.—This specimen may be fairly closely compared with the *Stachyotaxus elegans* of Nathorst(1). Seward(2) has also figured two obscure specimens from Victoria, of Jurassic age, as "Female flowers of Ginkgoales ?" to one of which there is some slight resemblance.

Occurrence.—Mokoia, Gore, Southland (? Lower Jurassic).

Phylum ANGIOSPERMÆ.

DICOTYLEDONES.

Plate XIV.

One of the most interesting features of the small collection of fossil plants from Waikato Heads is the occurrence of a *few* Angiospermous leaves. These all occur on a single specimen, which is figured on Plate XIV. When this specimen reached me at Cambridge the leaves in question were not exposed, and it was only by further "developing" the piece of shale in question that they were brought to light. Their occurrence is of particular interest, for otherwise this flora is entirely Mesophytic in type, and it is clear that the Angiosperms were not the dominant race in the flora of Waikato Heads, as they are in nearly all Neophytic floras.

Some time ago I had the pleasure of showing the interesting specimen figured on Plate XIV to my friend Dr. L. Laurent, of Marseilles, an authority on the Tertiary floras. At my request he very kindly consented to write a note on the Angiosperms which occur associated with *Cladophlebis australis* (Morr.) at Waikato Heads, and I include here a translation of the note in question. I would return my sincere thanks to Dr. Laurent for his kindness in describing these fossils for me.

A Note on the Dicotyledonous Remains of Waikato Heads.

By Dr. L. Laurent, Conservateur au Muséum d'Histoire Naturelle de Marseille.

A quite peculiar interest attaches to the discovery of Angiospermous remains of the Cretaceous period, since we know relatively little on the subject of the ancestral types of this group. The discoveries made, both in Europe and North America, have indeed carried the date of the appearance of the higher plants further back; but, spite of all, the number of the first representatives of those fossil plants which it has been possible to refer with certainty to the Angiosperms is relatively very small, notably as regards

(1) Nathorst (1908), p. 11, pl. ii.

(2) Seward (1904[1]), p. 179, pl. xix, fig. 39.

the Lower Cretaceous, and, as Professor Seward(1) has very justly remarked, "it is highly probable that the suddenness with which the Dicotyledons took their place in the vegetation of the world is exaggerated by the scantiness of our fossil records."

It is thus hardly possible to attach too much importance to the discoveries which have just added new material to that which was already known from the Cretaceous beds of New Zealand, and I am grateful to Dr. E. A. Newell Arber for having confided to me the task of describing these remains belonging to the Dicotyledons, derived from the beds of Waikato Heads, in Auckland, New Zealand.

These remains are, unfortunately, neither very numerous nor very well preserved. One finds imprinted on a large slab, mingled with numerous remains of fronds of *Cladophlebis australis* (Morr.), three leaves of Dicotyledons (Plate XIV, at *a*, *b*, and *c*) the value of which is very unequal. One of them represents the apical part of a leaf (*a*), another a base (*b*), and a third (*c*) is so fragmentary that it can scarcely be utilized, some secondary nerves alone being visible. The nervation of the first two examples is well preserved, and can be studied in all its details. The characters which one can deduce from it, combined with an examination of the large nerves and the form(?), allow one to arrive at a fairly clear idea as to these two impressions (*a* and *b*), which probably belong to the same type.

ARTOCARPIDIUM Unger, 1850.

(*Denkschr. k. Acad. Wissen. Wien (Math.-Nat. Cl.)*, vol. ii, p. 166.)

Artocarpidium Arberi sp. nov. Plate XIV, *a*, *b*.

Diagnosis.—A. foliis ovatis ? trinerviis ? ; petiolo brevi ; margine integra ; nervis secundariis oppositis ; tertiario ultimoque reticulo in modum Artocarpearum disposito.

Description of the Specimen.—Some idea of the form of the leaf can be arrived at by reconstructing it from the basal and apical portions occurring on the same slab. As a matter of fact, the angle of the secondary nerves is about 30°, the contour presents an analogous curve, and as the network of the tertiary veins in both cases is identical it appears to me to be quite logical to assign these two fragments to the same species. Nevertheless, in the description which I am about to give of it I have especially in view the upper part, which, from the point of view of the nervation, is better preserved.

The leaf must have been coriaceous, judging by the impression which it has left on the sediments, and its general form was oval (?). The base is cordate, the margin entire.

All the veins are prominent. The limb is traversed by a straight and strong median nerve, which forms a continuation of a short petiole, but it is somewhat difficult to see from the impression whether it has been broken or whether we possess it entire. The secondary nerves, which are camptodromous, opposite, or subopposite, emerge from the midrib at an angle of about 30°, which remains the same throughout the whole extent of the limb, except towards the base, where it is a little more open. The first two basal nerves are opposite, and give off on their outer sides rather weak secondary nerves, so far as one can judge from the specimen.

The tertiary network is very important. It is composed of nerves, sometimes straight, sometimes anastomosing, forming a polygonal network between the secondary nerves. These nerves meet the midrib at right angles, and the neighbouring secondary nerve at a slightly more open angle, which gives the whole network a general aspect of a succession of flattened arches (*arque surbaissé*). There are no secondary incomplete nerves terminating within the network. The ultimate nervation is constituted by the reunion of branchlets forming among themselves an irregularly polygonal mesh.

(1) Seward (1904²), p. 155.

Remarks.—In comparison with *living* forms, if we consider the nervations of different orders separately we can compare this fossil with a large number of living forms, but the field of investigation is limited if we compare the relations of the different networks among themselves. The physiognomy of the fossil leaf depends especially on the angle of emergence of the secondary nerves, the mode of union (*rapprochement*) of the tertiary veins, and especially their behaviour in relation to the median nerve, which they meet at right angles, thus giving the whole network the appearance of concentric flattened arches (*un aspect concentrique surbaissé*). This last character especially rules out the tropical Rubiaceæ, such as the Gardenias of New Caledonia, and the Rhamnaceæ of the same region, such as *Alphitonia*. Certain Cornaceæ show a horizontal nervation, but differ very much on account of the relative importance of the secondary nerves. Many Euphorbiaceæ have leaves of a somewhat similar aspect, but the much more crowded and rarely bifurcated tertiary network, and the disposition of the ultimate mesh, renders the comparison untenable. Certain Styraceæ (*Styrax ferrugineum* Pohl., of Brazil) might be brought into line with our fossil but for the less bifurcated tertiary network, and its relations with the median and secondary nerves.

Among the Dilleniaceæ the genus *Tetracera* (*T. Euryandra* Vahl.) presents a tertiary network and an ultimate mesh very similar to that of the New Zealand fossil, if one considers only the portion included between two secondary nerves, but in its entirety the aspect is very different.

Pterospermum lanceæfolium Roxb., among those Sterculiaceæ which have a regular base, suggests itself at first glance, but the tertiary network is very different. While in the fossil it is reticulated, forming an irregularly polygonal mesh, the tertiary nerves are generally simple in *Pterospermum*, and, what is more, the ultimate mesh is elongated in a direction perpendicular to that of the fossil, being parallel to the secondary nerves.

Finally, we meet among the Artocarpeæ closer grounds for comparison in *Ficus*, *Olmedia*, and *Artocarpus*. Among the members of the genus *Ficus*, a large number, which have a tertiary nervation parallel to the secondary nerves, may be eliminated, but we find other species which present a network whose appearance is analogous to that which one observes in the fossil, especially in certain species of *Ficus* from Timor, which, except for a tendency to incompleteness of the secondary nerves, present the other characters of the fossil. The same is the case with *Ficus Sakalavarum* Bak. of Madagascar, in which the basal nerves are much more prominent. In *Olmedia* and *Artocarpus* (*Artocarpus rigida* B.C.) of the East Indian region, one does not see so marked a tendency to form incomplete secondary nerves as in *Ficus*. Except as regards the dimensions and the alternation of the secondary nerves, which are features of quite minimal importance, the other characters agree well with those observed in the fossil. It is thus with this group that the affinities of the fossil appear to lie closest.

As we cannot hope to meet with absolute identity between the modern genus and so ancient a fossil, we will place the latter in the fossil genus *Artocarpidium* Ung.

The authors who have adopted this genus have had especially in view the remains of the fructiferous receptacle; as for the foliar remains, they have been so little elucidated that they cannot be taken into consideration. For our part, the term *Artocarpidium* recalls especially the relations of comparative nervation which we find between the New Zealand fossil and the group of modern Artocarpeæ.

The comparison with *fossil forms*, including those already described in the numerous Cretaceous floras of both hemispheres, is rendered extremely difficult by the almost entire absence of nervation in the figures given by the authors. None of the fossils described by Ettingshausen(1) from the Cretaceous and Tertiary rocks of New Zealand can be compared with the impression here described. The same author(2), in the

1) Ettingshausen (1887[1]).

(2) Ettingshausen (1895), p. 22, pl. ii, fig. 11.

study which he has made of the Cretaceous flora of Australia, quotes an *Artocarpidium pseudo-cretaceum* Ett., and compares it with *A. cretaceum* Ett. from the chalk of Niederschöna(1). However, the figures given are quite rudimentary, and neither from them nor from the descriptions of this author can one establish any sort of comparison. As to *Ficus ipswichiana* Ett.(2), one cannot from the fragment of nervation drawn arrive at any idea of what it may be.

No equivalent to this fossil is to be found among the forms from the Cretaceous of Bohemia. On the other hand, we find a certain analogy with *Credneria Zenkeri* var. *acuminata* Rich.(3), especially as regards the tertiary nervation, but the arrangement of the secondary nerves and the form of the base are entirely different from that which we observe in the New Zealand fossil.

We cannot point to any satisfactory comparison with the numerous examples of *Ficus* described by Hosius and von der Marck(4) from the Cretaceous of Westphalia. In America, Lesquereux(5) figures in the flora of the Dakota group a *Ficus*, *F. distorta* Lesq., which presents no similarity to our example. Nor do we find any similarity with species from the Cretaceous of the Arctic regions, noticed by Heer in the *Flora Fossilis Arctica*, nor with those from Nebraska(6).

Certain Artocarpidiums have been recorded in the Tertiary floras of Europe—at Sotzka by Unger, and at Bilin and Monte Promina by Ettingshausen. However, the tertiary and ultimate nervations, which are the bases of comparison with recent or fossil examples, are completely wanting in the figures of the fossils mentioned.

It follows that the type of Waikato Heads deserves to be classed apart in the series of interesting fossil forms of the Lower Cretaceous period. Its Artocarpic nervation constitutes a very well-defined type in the series of primitive Dicotyledons, which, from the Lower Cretaceous period, emerge to our view with characters which are all but definitive, and which will come to characterize in due course the entire group in a general manner, without modifications of any importance. From this point of view this fossil, incomplete as it is, presents great interest, and I name it *Artocarpidium Arberi* sp. nov.

Genus PHYLLITES Sternberg, 1826.

(*Vers. Darstell. Flora Vorwelt*, Heft vi, p. xlvi.)

Phyllites sp. Plate XIVc.

Description of the Specimen.—Another very fragmentary leaf occurs on the same slab as the last specimens (Plate XIVc). Parts of three pairs of secondary nerves, which bifurcate at a short distance from their emergence from the midrib, are alone visible.

The data for comparison are here entirely lacking, and it is best not to assign a species to this fossil, which is evidently a Dicotyledonous fragment. It would be possible, moreover, to compare it to a great number of fossils described in the Cretaceous and Tertiary floras, without adding anything to our knowledge.

INCERTÆ SEDIS.

Genus CARPOLITHUS Sternberg, 1833.

(*Vers. Darstell. Flora Vorwelt*, Heft v, vi, pl. xl.)

Carpolithus McKayi sp. nov. Plate XI, fig. 6.

Diagnosis.—Seed small, oval, slightly pointed at one end, more or less rounded at the other, 11·5 mm. long and 9 mm. across at its widest point. Central "nucule"

(1) Ettingshausen (1867), p. 251, pl. ii, fig. 4.
(2) Ettingshausen (1895), p. 22, pl. ii, fig. 12*a*.
(3) Richter (1905), p. 12, pl. ii, fig. 5.
(4) Hosius and von der Marck (1880).
(5) Lesquereux (1883), p. 48, pl. xiv, fig. 4.
(6) Capellini and Heer (1867).

prominent, distinct, about 8·5 mm. long and 5·5 mm. across, slightly pointed at one end and rounded at the other, with a well-marked median groove. "Nucule" surrounded by a narrow rim or wing, of somewhat unequal breadth.

Remarks.—This seed is similar in type to many others occurring in Mesozoic rocks in various parts of the world. It has some resemblance to the *Samaropsis* cf. *S. parvula* of Feistmantel(1), from the Talchir group (Rhætic) of India, and to the *Carpolithes cinctus* of Nathorst(2), from the Rhætic of Höganäs, Sweden, though it is probably specifically distinct from either.

Type.—New Zealand Geological Survey collection.

Occurrence.—Wairoa Gorge, Mount Heslington, Nelson (Mesozoic).

Obscure Fructifications ? Plate XIII, figs. 2, 3, 5, 6.

Description of the Specimens.—In the collection from Waikato Heads a number of specimens occur showing branched axes, the primary branches being stout, and the secondary bearing a number of minute indistinct bodies at unequal intervals. Two of these are figured (enlarged) on Plate XIII, figs. 2 and 6. The latter shows a very stout primary and a slender secondary axis, bearing very indistinct oval organs. In one case the organs in question are borne on a branch of the third order. They do not appear to be seeds, but look more like sporangia, under the microscope.

The other specimen (fig. 2, twice enlarged) shows the fructifications (?) more clearly. They vary somewhat in size and shape, being subcircular, oval, or elliptical. Less distinct specimens are figured (somewhat enlarged) on figs. 3 and 5 of the same plate. These again show a fairly broad primary axis, and fructifications (?) borne on slender branches.

Remarks.—The nature of these fossils appears to me to be wholly obscure, and I am not acquainted with any to which they may be at all closely compared. There may be some resemblance to the fructifications from the Jurassic rocks of Siberia, ascribed by Heer(3) to *Ginkgo*, but the comparison is by no means a close one. A nearer case perhaps is Fontaine's(4) *Baieropsis pluripartita*, and one of the Victorian specimens figured by Seward(5) as "female flowers of Ginkgoales ?"

I am unable to express any opinion as to the nature of these fossils. They do not appear to be roots and root-tubercles. I think they are more probably fertile shoots bearing sporangia, but as to the class of plants to which they should be referred there appears at present to be no evidence.

Occurrence.—Waikato Heads, Auckland (Neocomian).

"Roots," Plate X, fig. 4.

The occurrence of beds full of rootlets, on the same horizon as those containing other plant-remains at Mataura Falls, was noted by McKay(6). Plate X, fig. 4, shows one of these roots. This specimen is in the British Museum collection (No. V. 11678). The lateral roots appear to be arranged spirally. It is quite impossible, of course, to say to what genus these roots belong.

(1) Feistmantel (1886), vol. iv, pt. ii, p. 45, pl. xii*a*, figs. 7–15.
(2) Nathorst (1878[3]), *Younger Flora*, p. 52, pl. ii, figs. 2*a*, 3.
(3) Heer (1876[2]), pl. xi, figs. 9–12 ; (1878), pl. vi, fig. 8 ; (1880), pl. iv, &c. ; *cf.* also Krystofovic (1910), pl. iii, fig. 5.
(4) Fontaine (1889), pl. xc, figs. 4, 4*a*.
(5) Seward (1904[1]), pl. xix, fig. 40.
(6) McKay (1881), p. 40.

BIBLIOGRAPHY.

Antevs, E. (1913). Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia, 1910–13. V. Some Mesozoic Plants. *K. svenska Vet.-Akad. Handl.*, vol. lii, No. 5; 1913.

Antevs, E. (1914). Die Gattungen *Thinnfeldia* Ett. und *Dicroïdium* Goth. *K. svenska Vet.-Akad. Handl.*, vol. li, No. 6; 1914.

Arber, E. A. N. (1902). On the Clarke Collection of Fossil Plants from New South Wales. *Quart. Journ. Geol. Soc.*, vol. lviii, p. 1; 1902.

Arber, E. A. N. (1905). Catalogue of the Fossil Plants of the *Glossopteris* Flora in the Department of Geology, British Museum (Nat. Hist.). *Brit. Mus. Cat.* London; 1905.

Arber, E. A. N. (1913[1]). A Preliminary Note on the Fossil Plants of the Mount Potts Beds, New Zealand, collected by Mr. D. G. Lillie, Biologist to Captain Scott's Antarctic Expedition in the "Terra Nova." *Proc. Roy. Soc.*, Ser. B, vol. lxxxvi, p. 344; 1913.

Arber, E. A. N. (1913[2]). On the Earlier Mesozoic Floras of New Zealand. *Proc. Camb. Phil. Soc.*, vol. xvii, p. 122; 1913.

Berry, E. W. (1911). The Lower Cretaceous Deposits of Maryland. *Maryland Geol. Surv., Lower Cretaceous.* Baltimore; 1911.

Brongniart, A. (1828). *Histoire des Végétaux fossiles,* vol. i; 1828–37.

(1828.)	pp. i–xii, 1–136, pls. i–xxvii.
(1829.)	pp. 137–208, pls. xxviii–xxxvi, xxxviii–xlix, li–lii, liv–lvi, lxi, lxvi.
(1830.)	pp. 209–248, pls. l, liii, lvii–lviii, lxi *bis*, lxii, lxiv, lxv, lxvii, lxviii, lxx, lxxi, lxxiii, lxxvi.
(1831–32.)	249–264, pls. lix, lx, lxiii, lxix, lxxii, lxxiv, lxxv, lxxvii–lxxxii.
(1832–33.)	pp. 265–288, pls. lxxxiii–xcvii.
(1833–34.)	pp. 289–312, pls. lxxxii A, xcviii–cix.
(1834.)	pp. 313–336, pls. cx–cxiv, cxvii, cxviii, cxxiv, cxxvii, cxxviii, cxxx.
(1835–36.)	pp. 337–368, pls. cxv, cxvi, cxix–cxxiii, cxxv, cxxvi, cxxix, cxxxi–cxxxiv.
(1836.)	pp. 369–488, pls. cxxxv–clx, xxxvii, xxxvii *bis*, lxxxii B.
(1837.)	pls. clxi–clxvi.

Brongniart, A. (1849). Tableau des genres de végétaux fossiles, &c. *Diction. Univ. Hist. natur.*, vol. xiii, p. 52. Paris; 1849.

Bronn, H. G. (1858). Beiträge zur triasischen Fauna und Flora der bituminösen Schiefer von Raibl. IV. *Jahrb. für Mineral., Jahr.* 1858, p. 143; 1858.

Bunbury, C. J. F. (1847). Descriptions of Fossil Plants from the Coalfield near Richmond, Virginia. *Quart. Journ. Geol. Soc.*, vol. iii, p. 281; 1847.

Bunbury, C. J. F. (1851). On some Fossil Plants from the Jurassic Strata of the Yorkshire Coast. *Quart. Journ. Geol. Soc.*, vol. vii, p. 179; 1851.

Capellini, J., and Heer, O. (1867). Les Phyllites crétacées du Nebraska. *N. Denksch. Schweiz. Gesellsch Naturw.*, vol. xxii (dec. 3, vol. ii), p. 1; 1867.

Carruthers, W. (1872.) In Daintree, R.: Notes on the Geology of the Colony of Queensland. Appendix II: Notes on Fossil Plants from Queensland, Australia. *Quart. Journ. Geol. Soc.*, vol. xxviii, p. 350; 1872.

Cox, S. H. (1877). Report on Waikato District. *Rep. Geol. Explor. Geol. Surv. New Zealand,* during 1876–77, No. 10, p. 11· 1877.

Cox, S. H. (1878). Report on the Geology of the Hokanui Ranges, Southland. *Rep. Geol. Explor. Geol. Surv. New Zealand*, during 1877–78, No. 11, p. 25; 1878.

Crié, L. (1888). Sur les affinités des flores jurassiques et triassiques de l'Australie et de la Nouvelle-Zélande. *Compt. Rend. Acad. Sci.*, vol. cvii, p. 1014; 1888.

Crié, L. (1889). Beiträge zur Kenntniss der fossilen Flora einiger Inseln des Süd-pacifischen und Indischen Oceans. *Dames u. Kayser, Palæontol. Abhandl.*, vol. v, (N.F., vol. i), Heft 2; 1889.

Dawson, J. W. (1886). On the Mesozoic Floras of the Rocky Mountain Region of Canada. *Proc. and Trans. Royal Soc. Canada*, vol. iii, sec. iv, for 1885, p. 1; 1886.

Debey, M. H., and Ettingshausen, C. (1859). Die urweltlichen Thallophyten des Kreidegebirges von Aachen and Maestricht. *Denksch. k. Akad. Wissen. Wien (Math.-Nat. Cl.)*, vol. xvi, p. 131; 1859.

Eichwald, E. (1860). *Lethæa Rossica*. Stuttgart. Vols. 1–3; 1860–65.

Etheridge, R., Jun. (1888). Additions to the Fossil Flora of Eastern Australia. *Proc. Linn. Soc. N.S. Wales*, vol. iii, pt. iii, p. 1300; 1888.

Etheridge, R., Jun. (1892). In H. G. L. Brown: Further Geological Examination of Leigh's Creek and Hergott Districts, &c., South Australia. (Government Publication.) Adelaide; 1892.

Etheridge, R., Jun. (1894[1]). *Palæontologia Novæ Cambriæ Meridionalis*. Occasional Descriptions of New South Wales Fossils. No. 1. *Rec. Geol. Surv. N.S. Wales*, vol. iv, pt. i, p. 32; 1894.

Etheridge, R., Jun. (1894[2]). On the Occurrence of *Oleandridium* in the Hawkesbury Sandstone Series. *Rec. Geol. Surv. N.S. Wales*, vol. iv, pt. ii, p. 49; 1894.

Etheridge, R., Jun. (1895). Additional Plant-remains from the Leigh Creek Coalfield, Central Australia. *Trans. Roy. Soc. South Australia*, vol. xix, p. 138; 1895.

Etheridge, R., Jun. (1899). On a Fern (*Blechnoxylon talbragarense*) with Secondary Wood, forming a New Genus, from the Coal-measures of the Talbragar District, New South Wales. *Rec. Austr. Mus.*, vol. iii, p. 135; 1899.

Ettingshausen, C. von (1867). Die Kreideflora von Niederschoena in Sachsen, &c. *Sitzung. k.k. Akad. Wissen. Wien*, vol. lv, Abth. i, p. 235; 1867.

Ettingshausen, C. von (1887). Beiträge zur Kenntniss der fossilen Flora Neuseelands. *Denkschr. k. Akad. Wissen. Wien (Math.-Nat. Cl.)*, vol. liii, pt. 1, p. 143; 1887. Summary in *Geol. Mag.*, Dec. 3, vol. iv, p. 363; 1887. Translated in *Trans. N.Z. Inst.*, vol. xxiii, p. 237; 1890.

Ettingshausen, C. von (1887[2]). In Haast, Sir J. von: Notes on the Age and Subdivisions of the Sedimentary Rocks in the Canterbury Mountains, &c. *Trans. and Proc. N.Z. Inst.* for 1886, vol. xix, p. 449; 1887.

Ettingshausen, C. von (1887[3]). On the Fossil Flora of New Zealand. *Geol. Mag.*, Dec. 3, vol. iv, p. 363; 1887.

Ettingshausen, C. von (1891). Contributions to the Knowledge of the Fossil Flora of New Zealand. *Trans. and Proc. N.Z. Inst.*, vol. xxiii (N.S., vol. iv for 1890), p. 237; 1891.

Ettingshausen, C. von (1895). Beiträge zur Kenntniss der Kreideflora Australiens. *Denkschr. k. Akad. Wissen. Wien (Math.-Nat. Cl.)*, vol. lxii, p. 1; 1895.

Feistmantel, O. (1876[1]). Jurassic (Oolitic) Flora of Kach. *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. ii, pt. i; 1876.

Feistmantel, O. (1876[2]). Palæontologische Beiträge. I. Ueber die Indischen Cycadengattungen *Ptilophyllum* Morr., &c. *Palæontogr.*, Suppl. iii, Lief. 3; 1876.

Feistmantel, O. (1877[1]). Jurassic (Liassic) Flora of the Rajmahal Group, in the Rajmahal Hills. *Foss. Flora Gondw. Syst. (Pal. Indica)*, vol. i, pt. ii; 1877.

Feistmantel, O. (1877[2]). Jurassic (Liassic) Flora of the Rajmahal Group, from Golapili (near Ellore), South Godavari District. *Foss. Flora Gond. Syst. (Pal. Indica)*, vol. i, pt. iii; 1877.

Feistmantel, O. (1877[3]). Flora of the Jabalpur Group (Upper Gondwanas) in the Son-Narbada Region. *Ibid.*, vol. ii, pt. ii; 1877.

Feistmantel, O. (1879). Outliers on the Madras Coast. *Ibid.*, vol. i, pt. iv; 1879.

Feistmantel, O. (1886). The Fossil Flora of some of the Coalfields in Western Bengal. *Ibid.*, vol. iv, pt. ii; 1886.

Fontaine, W. M. (1883). Contributions to the Knowledge of the Older Mesozoic Flora of Virginia. *Monogr. vi, U.S. Geol. Surv.*; 1883.

Fontaine, W. M. (1889). The Potomac or Younger Mesozoic Flora. *Monogr. xv, U.S. Geol. Surv.*; 1889.

Gœppert, H. R. (1836). Systema Filicum Fossilium. *Nov. Act. Acad. C.L.-C. Natur. Cur.*, vol. xvii (suppl. vol.); 1836.

Gothan, W. (1912). Über die Gattung *Thinnfeldia* Ettingshausen. *Abhandl. Naturhist. Gesellsch. Nürnberg*, vol. xix, p. 67; 1912.

Grand' Eury, C. (1890). *Géologie et Paléontologie du Bassin houiller du Gard.* Text et Atlas. St. Étienne; 1890.

Haast, J. (1871). Preliminary Report on the Malvern Hills, Canterbury. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1870–71, p. 135; 1871.

Haast, J. (1872[1]). Report on the Geology of the Malvern Hills, Canterbury. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1871–72, p. 1; 1872.

Haast, J. (1872[2]). Report on the Coal-deposits of the Ashburton District, Province of Canterbury. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1871–72, p. 141; 1872.

Haast, J. (1877). Notes on the Geology of the Clent Hills and Mount Somers Districts in the Province of Canterbury. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1873–74, p. 1; 1877.

Haast, J. (1885). On the Geological Structure of the Southern Alps of New Zealand, in the Provincial Districts of Canterbury and Westland. *Trans. and Proc. N.Z. Inst.* for 1884, vol. xvii, p. 332; 1885.

Haast, Sir J. von (1887). Notes on the Age and Subdivisions of the Sedimentary Rocks in the Canterbury Mountains, based on the Palæontological Researches of Professor Dr. C. Baron von Ettingshausen in Gratz (Austria). *Trans. and Proc. N.Z. Inst.* for 1886, vol. xix, p. 449; 1887.

Halle, T. G. (1913[1]). The Mesozoic Flora of Grahamland. *Wissenschaft. Ergebn. Schwed. Südpolar-Exped., 1901–3*, Bd. iii, Lief. 14; 1913.

Halle, T. G. (1913[2]). Some Mesozoic Plant-bearing Deposits in Patagonia and Tierra del Fuego and their Floras. *K. svenska Vet.-Akad. Handl.*, vol. li, No. iii; 1913.

Hartz, N. (1896). Planteforsteninger fra Cap Stewart i Ostgrönland. *Med. Grönland*, vol. xix, p. 217; 1896.

Hector, Sir J. (1869). Progress Report. *Abstr. Rep. Progr. Geol. Surv. New Zealand* during 1868–69, p. i; 1869.

Hector, Sir J. (1870). *Catalogue of the Colonial Museum, Wellington, New Zealand.* Wellington: 1870.

Hector, Sir J. (1871). On the Geological Structure of the Malvern Hills District, Canterbury. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1870–71, p. 46; 1871.

Hector, Sir J. (1877). Progress Reports: Clent Hills and Mount Somers. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1873–74, p. v; 1877.

HECTOR, Sir J. (1878[1]). Progress Reports: Mount Potts. *Rep. Geol. Explor. Geol Surv. New Zealand* during 1877–78, p. iv; 1878.

HECTOR, Sir J. (1878[2]). On the Relative Ages of the Australian, Tasmanian, and New Zealand Coalfields. *Trans. and Proc. N.Z. Inst.* for 1877, vol. x, p. 532; 1878.

HECTOR, Sir J. (1878[3]). Progress Reports: Southland District. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1877–78, p. vi; 1878.

HECTOR, Sir J. (1879[1]). On the Fossil Flora of New Zealand. *Trans. and Proc. N.Z. Inst.* for 1878, vol. xi, p. 536; 1879.

HECTOR, Sir J. (1879[2]). Official Catalogue, New Zealand Court, Internat. Exhib., Sydney, 1879: Appendix, pp. 48, 49.

HECTOR, Sir J. (1879[3]). Progress Reports: Geology. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1878–79, p. 2; 1879.

HECTOR, Sir J. (1880). On the Geological Formations of New Zealand compared with those of Australia. *Journ. and Proc. Roy. Soc. N.S. Wales* for 1879, vol. xiii, p. 65; 1880.

HECTOR, Sir J. (1881[1]). [Mataura District]. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1879–80, p. xv; 1881.

HECTOR, Sir J. (1881[2]). Progress Reports. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1879–80, p. 1; 1881.

HECTOR, Sir J. (1885). Note on the Geological Structure of the Canterbury Mountains. *Trans. and Proc. N.Z. Inst.* for 1884, vol. xvii, p. 337; 1885.

HECTOR, Sir J. (1886[1]). *Detailed Catalogue and Guide to the Geological Exhibits, New Zealand Court, Indian and Colonial Exhibition, London.* Wellington; 1886.

HECTOR, Sir J. (1886[2]). Progress Report; 1885. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1885, p. ix; 1886.

HEER, O. (1865). Die Urwelt der Schweiz. Zurich; 1865.

HEER, O. (1874). Die Kreide Flora der Arctischen Zone. *K. svenska Vet.-Akad. Handl.*, vol. xii, No. 6; 1874. =*Flora Foss. Arctica*, vol. iii, pt. ii; 1874.

HEER, O. (1876[1]). Beiträge zur fossilen Flora Spitzbergens, &c. *K. svenska Vet.-Akad. Handl.*, vol. xiv, 5; 1876. =*Flora Foss. Arctica*, vol. iv, pt. i; 1876.

HEER, O. (1876[2]). Beiträge zur Jura-Flora Ostsibiriens und des Amurlandes. *Mém. Acad. Sci. St. Pétersbourg*, Ser. 6, vol. xxii, No. 12; 1876. =*Flora Foss. Arctica*, vol. iv, pt. ii; 1876.

HEER, O. (1876[3]). *Flora Fossilis Helvetiæ. Die vorweltliche Flora der Schweiz.* Livr. i and ii, 1876; Livr. iii, 1877. Zurich; 1876–77.

HEER, O. (1878). Beiträge zur fossilen Flora Sibiriens und des Amurlandes. *Mém. Acad. Sci. St. Pétersbourg*, Ser. 7, vol. xxv, No. 6; 1878. =*Flora Foss. Arctica*, vol. v, pt. ii; 1878.

HEER, O. (1880). Nachträge zur Jura-Flora Sibiriens, &c. *Mém. Acad. Sci. St. Pétersbourg*, vol. xxvii, No. 10; 1880. =*Flora Foss. Arctica*, vol. vi, pt. i, mem. i; 1880.

HEER, O. (1882). Flora Fossilis Gronlandica. Die fossile Flora Grönlands. *Flora Foss. Arctica*, vol. vi, pt. 22, and vol. vii; 1882–83.

HOLDEN, R. (1914). On the Relation between *Cycadites* and *Pseudocycas*. *New Phyt.*, vol. xiii, p. 334; 1914.

HOSIUS and VON DER MARCK. (1880). Die Flora der Westfälischen Kreideformation. *Palæontogr.*, vol. xxvi, Lief. 5, 6, p. 125, 1880; und Nachtrag, *Palæontgr.*, vol. xxxi, Lief. 4, p. 225; 1885.

HUTTON, F. W. (1866). Geological Report on the Lower Waikato District. *1st General Report, Geol. Surv. New Zealand*, p. 1; 1866 (? 1867).

HUTTON, F. W. (1885). Sketch of the Geology of New Zealand. *Quart. Journ. Geol. Soc.*, vol. xli, p. 191; 1885.

Hutton, F. W. (1900). The Geological History of New Zealand. *Trans. and Proc. N.Z. Inst.* for 1899, vol. xxxii, p. 159; 1900.

Johnston, R. M. (1887). Fresh Contribution to our Knowledge of the Plants of Mesozoic Age in Tasmania. *Papers and Proc. Roy. Soc. Tasmania* for 1886, p. 160; 1887.

Johnston, R. M. (1888). Systematic Account of the Geology of Tasmania. Hobart; 1888.

Johnston, R. M. (1894). Further Contributions to the History of the Fossil Flora of Tasmania, pts. i and ii. *Papers and Proc. Roy. Soc. Tasmania* for 1893, p. 170, 1894; for 1894–95, p. 57, 1896.

Kidston, R., and Gwynne-Vaughan, D. T. (1907). On the Fossil Osmundaceæ, pt. i. *Trans. Roy. Soc. Edinburgh,* vol. xlv, pt. iii, p. 759; 1907.

Kidston, R., and Gwynne-Vaughan, D. T. (1916). *Ibid.*, p. v, *Trans. Roy. Soc., Edinb.*, vol. l, pt. ii, p. 469; 1916.

Krystofovic, A. (1910). Jurassic Plants from Ussuriland. *Mém. Com. Géol. St. Pétersbourg,* N.S. Livr. 56; 1910.

Lesquereux, L. (1879). Description of the Coal Flora of the Carboniferous Formation of Pennsylvania, &c., vols. i–iii, 1880–84; atlas, 1879. *2nd Geol. Surv. Pennsylvania, Rep. Progr.*

Lesquereux, L. (1883). Contributions to the Fossil Flora of the Western Territories, pt. iii: The Cretaceous and Tertiary Floras. *Hayden's Rep. U.S. Geol. Surv. of the Territories,* vol. viii; 1883.

Leuthardt, F. (1903). Die Keuperflora von Neuewelt bei Basel. Theil I, Phanerogamen; Theil II, Kryptogamen. *Abhandl. Schweiz. Paläont. Gesell.*, vol. xxx, p. 1; vol. xxxi, p. 25; 1903–1904.

McCoy, Sir F. (1900). In Stirling, J., Reports on the Victorian Coalfields (No. 7). Notes on the Fossil Flora of South Gippsland. *Spec. Rep. Dept. Mines, Victoria.* Melbourne; 1900.

McKay, A. (1877). Reports relative to Collections of Fossils in the South-east District of the Province of Otago. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1873–74, p. 59; 1877.

McKay, A. (1878[1]). Report relative to the Collection of Fossils from the Mount Potts *Spirifer* Beds. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1877–78, p. 91; 1878.

McKay, A. (1878[2]). Notes on the Sections and Collections of Fossils in the Hokanui District. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1877–78, p. 49; 1878.

McKay, A. (1878[3]). Report on the Wairoa and Dun Mountain Districts. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1877–78, p. 119; 1878.

McKay, A. (1881). Mataura Plant-beds, Southland County. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1879–80, p. 39; 1881.

Marshall, P. (1911). Article on New Zealand in *Handbuch der Regionalen Geologie* (Edit. by Steinmann and Wilckens), vol. vii, pt. i. Heidelburg; 1911.

Marshall, P. (1912). *Geology of New Zealand.* Wellington; 1912.

Nathorst, A. G. (1878). *Beiträge zur fossilen Flora Swedens. Über einige rhätische Pflanzen von Palsjö in Schonen.* Stuttgart; 1878.

Nathorst, A. G. (1878[2]). Om Floran i Skanes Kolförande Bildningar. I, Floran vid Bjuf. *Sver. Geol. Undersökn,* Ser. C, Nos. 27, 33, 85; 1878–86.

Nathorst, A. G. (1878[3]). *Ibid.* II, Floran vid Höganäs och Helsingborg. *K. svenska Vet.-Akad. Handl.*, vol. xvi, No. 7; 1878.

Nathorst, A. G. (1890). Beiträge zur Mesozoischen Flora Japan's. *Denkschr. k. Akad. Wissen. Wien (Math.-Nat. Cl.),* vol. lvii, p. 43; 1890.

Nathorst, A. G. (1908). Paläobotanische Mitteilungen. 7. Über *Palissya*, *Stachyotaxus*, and *Palæotaxus*. *K. svenska Vet.-Akad. Handl.*, vol. xliii, No. 8; 1908.

Nathorst, A. G. (1909). Über die Gattung *Nilssonia* Brongn., mit besonderer berücksichtigung Schwedischer Arten. *K. svenska Vet.-Akad. Handl.*, vol. xliii, No. 12; 1909.

Oldham, T. (1860). On the Geological Relations, and probable Geological Age, of the Several Systems of Rocks in Central India and Bengal. *Mem. Geol. Surv. India*, vol. ii, p. 299; 1860.

Oldham, T., and Morris, J. (1863). Fossil Flora of the Rajmahal Series in the Rajmahal Hills. *Foss. Flora. Gondw. Syst. (Pal. Indica)*, vol. i, pt. i; 1863.

Park, J. (1887). On the Jurassic Rocks of the Hokonui Hills, Mataura, and Waikawa. *Rep. Geol. Explor. Geol. Surv. New Zealand* during 1886–87, p. 141; 1887.

Park, J. (1904). On the Subdivision of the Lower Mesozoic Rocks of New Zealand. *Trans. and Proc. N.Z. Inst.* for 1903, vol. xxxvi, p. 373; 1904.

Park, J. (1910). The Geology of New Zealand. Christchurch, Wellington, &c.; 1910.

Renault, B., and Zeiller, R. (1888). *Études sur le Terrain houiller de Commentry.* Vol. 2: *Flore Fossile.* Pt. i by R. Zeiller, pt. ii by B. Renault, pt. iii by Renault and Zeiller. Text, 1888–90; Atlas, 1888. St. Étienne.

Richter, P. B. (1905). Beiträge zur Flora der oberen Kreide Quedlinburgs. Theil I, Die Gattung *Credneria*. 1905.

Saporta, Le Comte de. (1873). *Paléontologie français.* 2nd Series: *Végétaux. Plantes Jurassiques*, vol. i. Paris; 1873.

Schenk, A. (1864). Beiträge zur Flora des Keupers und der rhaetischen Formation. *VII Bericht. Nat. Gesell. Bamburg.* 1864

Schenk, A. (1866). Ueber die Flora der schwarzen Schiefer von Raibl. *Würzburger Naturwissen. Zeitschrift*, Bd. 6, p. 10; 1866–67.

Schenk, A. (1867). *Die fossile Flora der Grenzschichten des Keupers und Lias Frankens.* Wiesbaden; 1867.

Schimper, W. P. (1869). *Traité de Paléontologie Végétale*, vols. i–iii. Paris; 1869–74.

Schoenlein, J. L., and Schenk, A. (1865). *Abbildungen von fossilen Pflanzen aus dem Keuper Frankens*, von Dr. J. L. Schoenlein. (Text by Schenk.) Wiesbaden; 1865.

Seward, A. C. (1894). The Wealden Flora, pt. i. *Brit. Mus. Catal.* London; 1894.

Seward, A. C. (1898). *Fossil Plants*, vol. i. Cambridge; 1898.

Seward, A. C. (1900). The Jurassic Flora. I. The Yorkshire Coast. *Brit. Mus. Catal.* London; 1900.

Seward, A. C. (1903). Fossil Floras of Cape Colony. *Ann. South African Mus.*, vol. iv, p. 1; 1903.

Seward, A. C. (1904[1]). On a Collection of Jurassic Plants from Victoria. *Rec. Geol. Surv. Victoria*, vol. i, pt. iii, p. 155; 1904.

Seward, A. C. (1904[2]). The Jurassic Flora. II. Liassic and Oolitic Floras of England. *Brit. Mus. Cat.* 1904.

Seward, A. C. (1907). Notes on Fossil Plants from South Africa. *Geol. Mag.* Dec. 5, vol. iv, p. 481; 1907.

Seward, A. C. (1910). *Fossil Plants*, vol. ii. Cambridge; 1910.

Seward, A. C. (1911). The Jurassic Flora of Sutherland. *Trans. Roy. Soc. Edinburgh*, vol. xlvii, pt. iv, p. 643; 1911.

Seward, A. C. (1914). Antarctic Fossil Plants. British Antarctic ("Terra Nova") Expedition, 1910. *Natural History Report, Geology*, vol. i, No. 1. London; 1914.

Seward, A. C., and Leslie, T. N. (1908). Permo-Carboniferous Plants from Vereeniging (Transvaal). *Quart. Journ. Geol. Soc.*, vol. lxiv, p. 109; 1908.

SINNOTT, E. W. (1914). Some Jurassic Osmundaceæ from New Zealand. *Ann. Bot.*, vol. xxviii, p. 471 ; 1914.

SHIRLEY, J. (1898). Additions to the Fossil Flora of Queensland. *Geol. Surv. Queensland, Bull. 7 ;* 1898.

SOLMS-LAUBACH, H. GRAF ZU (1899). In Steinmann, Beiträge zur Geologie und Palaeontologie von Sudamerika. VII. Das Auftreten und die Flora der rhätischen Kohlenschichten von La Ternera. (Chile.) *Neues Jahrb. Miner.* Beil.-Bd. xii, p. 593 ; 1899.

STEPHENS, J. (1890). An Attempt to synchronize the Australian, South African, and Indian Coal-measures. Part I : The Australian and New Zealand Formations. *Proc. Linn. Soc. N.S. Wales*, ser. ii, vol. iv (for 1889), p. 331 ; 1890.

STERNBERG, C. GRAF VON (1820). *Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt.* Leipzig ; 1820–38.

Heft 1, pp. 1–24, pls. i–xiii ; 1820.
,, 2, pp. 1–33, pls. xiv–xxvi ; 1821.
,, 3, pp. 1–39, pls. xxvii–xxxix ; 1824.
,, 4, pp. 1–48, pls. xl–lix and A–E ; 1826.
,, 5 and 6, pp. i–xlii, pls. i–xxvi ; 1833.
,, 7, pp. 1–220, pls. xvii–lxviii and A–B ; 1838.
,, 8, pp. 1–72 ; 1838.

STIRLING, J. (1900). Reports on the Victorian Coalfields. No. 7 : Notes on the Fossil Flora of South Gippsland. *Dept. Mines, Victoria, Spec. Rep. ;* 1900.

STOPES, M. C. (1907). The Flora of the Inferior Oolite of Brora (Sutherland). *Quart. Journ. Geol. Soc.*, vol. lxiii, p. 375 ; 1907.

SZAJNOCHA, L. (1881[1]). Über fossile Pflanzenreste aus Cacheuta in der Argentinischen Republik. *Sitzung. k. Akad. Wissen. Wien (Math.-Nat. Cl.)*, vol. xcvii, pt. i, p. 219 ; 1888.

SZAJNOCHA, L. (1888[2]). Ueber die von Dr. Rudolf Zuber in Süd-Argentina und Patagonien gesammelten Fossilien. *Verhandl. k.-k. Geol. Reichs. Wien* (für 1888), p. 146.

TENISON-WOODS, J. E. (1883). On the Fossil Flora of the Coal Deposits of Australia. *Proc. Linn. Soc. N.S. Wales*, vol. viii, p. 37 ; 1883.

THOMSON, J. A. (1913). Materials for the Palæontology of New Zealand. *Palæont. Bull. No. 1, N.Z. Geol. Surv. ;* 1913.

UNGER, F. (1864). Fossile Pflanzenreste aus Neu-Seeland. In Hochstetter, F. von ; Hörnes, M. ; Hauer, F. von : Paläontologie von Neu-Seeland. (Beiträge zur Kenntniss der fossilen Flora und Fauna der Provinzen Auckland und Nelson.) *Novara-Exped. Geol. Theil*, Bd. 1, Abtheil. 2, Pal. Wien ; 1864.

ZEILLER, R. (1890). Bassin Houiller et Permien d'Autun et d'Épinac. Fasc. ii, Flore Fossile. *Études Gîtes Minéraux France.* Text and atlas. Paris ; 1890.

ZEILLER, R. (1902). Observations sur quelques plantes fossiles des Lower Gondwanas. *Mem. Geol. Surv. India (Pal. Indica)*, N.S., vol. ii, pt. i ; 1902.

ZEILLER, R. (1914). Sur quelques plantes Wealdiennes recueillies au Pérou par M. le Captaine Berthon. *Rev. Génér. Botan.*, vol. xxv, *bis*, p. 647 ; 1914.

ZIGNO, A. DE (1856). *Flora Fossilis Formationis Oolithicæ. Le Plante fossili dell' Oolite.* Vols. 1 and 2. Padova ; 1856–85.

INDEX I.

GENERA AND SPECIES.

(Including a few Names of Families.)

Names of genera and species in Roman type are those described in the present volume. The principal page-references to these are shown in heavy type. Names in italics represent synonyms, or plants to which only passing reference is here made.

A.

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INDEX II.

GENERAL INDEX.

(For authors, see also "Biblography," pp. 66–72. A few important page-references are in heavy type).

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Plate I.

Fig. 1. *Elatocladus conferta* (Old. & Morr.). From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* Natural size. (Rhætic.)

Fig. 2. *Sphenopteris (Ruffordia) Gœpperti* Dunk. From Mokoia, Gore, Southland.* *No. 626 in For. Mes. Plant Coll., Sedgwick Mus., Camb.* Natural size. (? Lower Jurassic.)

Fig. 3. *Elatocladus conferta* (Old & Morr.). From the Malvern Hills, Canterbury. *No. 611 in For. Mes. Plant Coll., Sedgwick Mus., Camb.* Natural size. (Lower Jurassic.)

Fig. 4. *Sphenopteris (Ruffordia) Gœpperti* Dunk. From the same locality, and No. 627 in the same collection as Fig. 2. Natural size. (? Lower Jurassic.)

Fig. 5. *Sphenopteris otagoensis* sp. nov. From Owaka Creek, Catlin's River, Otago, Zealand. *New Zeal. Geol. Surv. Coll.* × 2. (? Rhætic.)

Fig. 6. *Sphenopteris otagoensis* sp. nov. From the same locality and in the same collection as Fig. 5. Natural size. (? Rhætic.)

Fig. 7. *Thinnfeldia odontopteroides* (Morr.). From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* Natural size. (Rhætic.)

Fig. 8. *Sphenopteris otagoensis* sp. nov. From the same locality and in the same collection as Fig. 5. Natural size. (? Rhætic.)

Fig. 9. *Thinnfeldia* sp. cf. *T. argentinica* (Gein.). From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* Natural size. (Rhætic.)

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* See footnote (1) on page 12.

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Sphenopteris, Thinnfeldia and Elatocladus.

Plate II.

Fig. 1. *Coniopteris hymenophylloides* (Brongn.). From Mokoia, Gore, Southland. *No. 632, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (? Lower Jurassic.)

Fig. 2. *Coniopteris hymenophylloides* (Brongn.). From the same locality, and No. 632 in the same collection. Natural size. (? Lower Jurassic.)

Fig. 3. *Coniopteris hymenophylloides* (Brongn.). From the same locality, and No. 631 in the same collection. Natural size. (? Lower Jurassic.)

Fig. 4. *Sphenopteris gorensis* sp. nov. From the same locality, and No. 628 in the same collection. Natural size. (? Lower Jurassic.)

Fig. 5. *Phyllotheca minuta* sp. nov. From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* Natural size. (Rhætic.)

Fig. 6. *Coniopteris hymenophylloides* (Brongn.). Fertile pinna. From the Malvern Hills, Canterbury. *No. 604, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* $\times \frac{3}{2}$. (Lower Jurassic.)

Fig. 7. *Sphenopteris Currani* (Ten.-Woods). From Mokoia, Gore, Southland. *No. 630, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (? Lower Jurassic.)

Fig. 8. *Sphenopteris Currani* (Ten.-Woods). A pinna of Fig. 7, enlarged to show the nervation. $\times \frac{5}{2}$. (? Lower Jurassic.)

Fig. 9. *Phyllotheca minuta* sp. nov. From the same locality and in the same collection as Fig. 5. Natural size. (Rhætic.)

Fig. 10. *Microphyllopteris* sp. From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* Natural size. (? Rhætic.)

Fig. 11. *Thinnfeldia* sp. From Mokoia, Gore, Southland. *No. 629, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (? Lower Jurassic.)

T. A. Brock del.

Phyllotheca, Coniopteris, Sphenopteris etc.

Plate III.

Fig. 1. *Linguifolium Lillieanum* Arber. Type specimen. From Mount Potts, Canterbury. *Brit. Mus. (Nat. Hist.).* $\times \frac{7}{4}$. (Rhætic.)

Fig. 2. *Equisetites Nicoli* sp. nov. From Mokoia, Gore, Southland. *No. 633, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (? Lower Jurassic.)

Fig. 3. *Coniopteris hymenophylloides* (Brongn.). Partly fertile frond. Same specimen as Fig. 4 enlarged. $\times$ 2. (? Lower Jurassic.)

Fig. 4. *Coniopteris hymenophylloides* (Brongn.). Partly fertile frond. From the Malvern Hills, Canterbury. *No. 622, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (Lower Jurassic.)

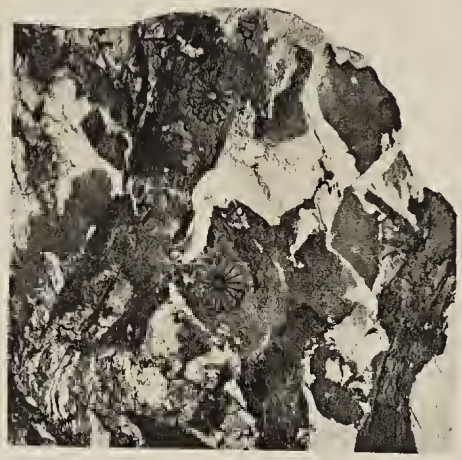
Fig. 5. *Coniopteris hymenophylloides* (Brongn.). Sterile frond. From the same locality, and No. 623 in the same collection. Natural size. (Lower Jurassic.)

Fig. 6. *Sphenopteris* sp. From the same locality, and No. 624 in the same collection. $\times$ 2. (Lower Jurassic.)

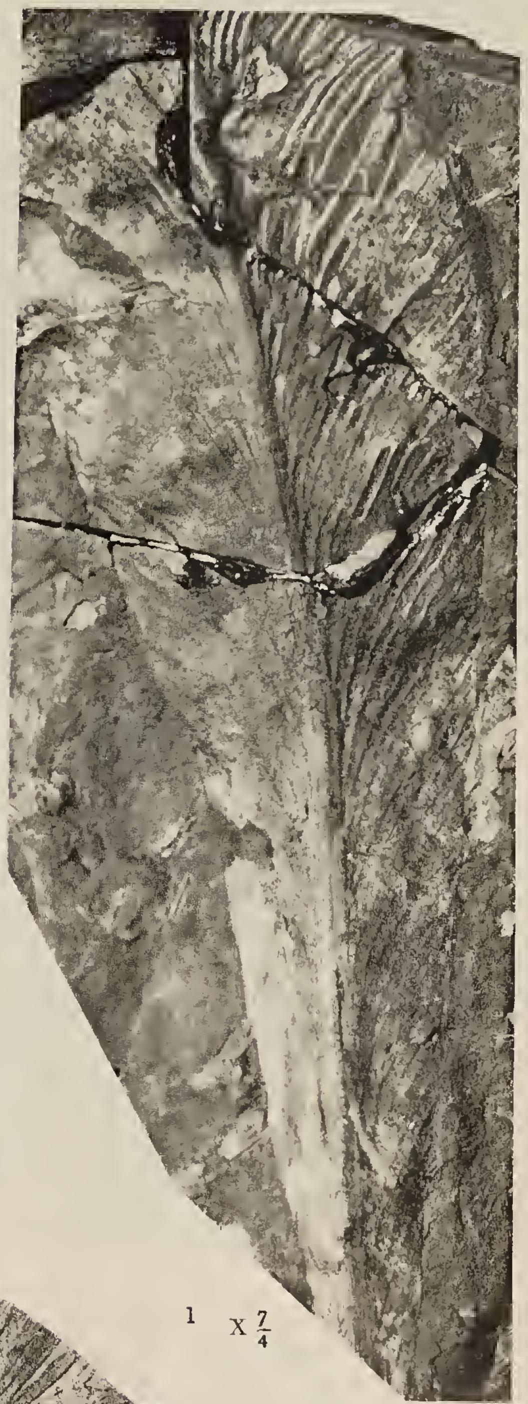
Fig. 7. *Linguifolium Lillieanum* Arber. From Mount Potts, Canterbury. *Brit. Mus. (Nat. Hist.).* $\times \frac{3}{2}$. (Rhætic.)

Fig. 8. *Chiropteris lacerata* Arber. From Mount Potts, Canterbury. *Brit. Mus. (Nat. Hist.).* $\times \frac{3}{2}$. (Rhætic.)

3 X2



2



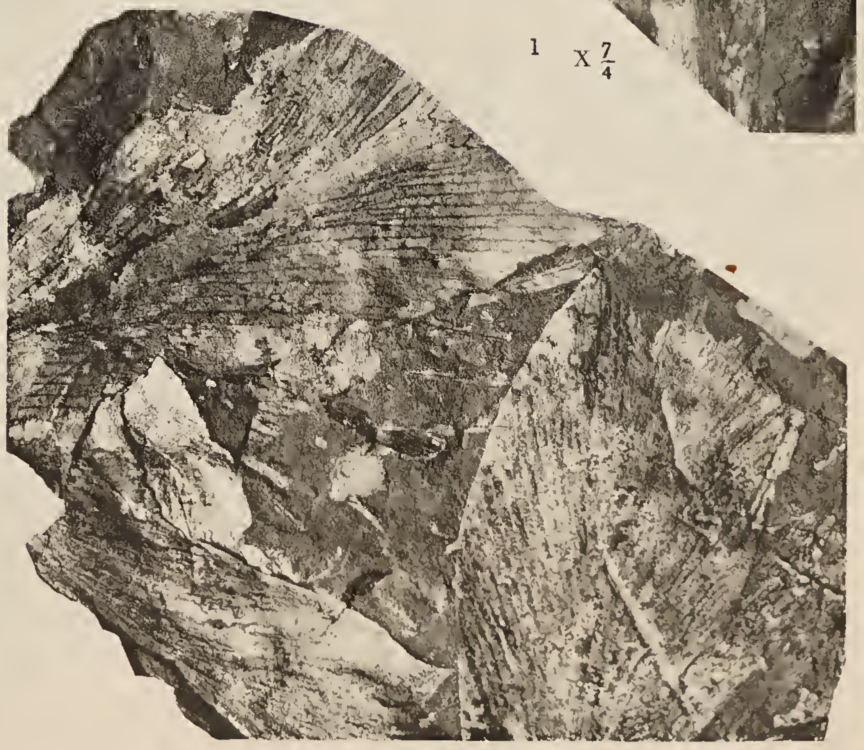
1 X $\frac{7}{4}$

6 X2

5

4

8 X $\frac{8}{2}$



7 X $\frac{3}{2}$

W. Tams, photo.

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Equisetites, Linguifolium, Chiropteris etc.

Plate IV.

Fig. 1. *Cladophlebis australis* (Morr.). From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* Natural size. (Neocomian.)

Fig. 2. *Cladophlebis* cf. *C. Albertsi* (Dunk.). From the same locality, and V. 11636 in British Museum collection. Natural size. (Neocomian.)

Fig. 3. *Cladophlebis* cf. *C. Albertsi* (Dunk.) From the same locality and in the same collection. Natural size. (Neocomian.)

Fig. 4. *Tæniopteris vittata* Brongn. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Middle Jurassic.)

Fig. 5. *Cladophlebis australis* (Morr.). From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* Natural size. (? Rhætic.)

Fig. 6. *Cladophlebis denticulata* Brongn. Pinnules enlarged to show the nervation and denticulation. From Mataura Falls, Southland. *V. 11700, Brit. Mus. (Nat. Hist.).* $\times \frac{5}{2}$. (Middle Jurassic.)

Fig. 7. *Cladophlebis* sp. From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (Neocomian.)

Fig. 8. *Cladophlebis australis* (Morr.). From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* $\times \frac{9}{4}$. (Neocomian.)

2 3 1 5 4

7 X2

8 X $\frac{9}{4}$

6 X $\frac{5}{2}$

W. Tams, photo.

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Cladophlebis and Tæniopteris.

Plate V.

Fig. 1. *Thinnfeldia lancifolia* (Morr.). From Mount Potts, Canterbury. *Brit. Mus. (Nat. Hist.)*. Natural size. (Rhætic.)

Fig. 2. *Thinnfeldia lancifolia* (Morr.). From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* $\times \frac{5}{3}$. (? Rhætic.)

Fig. 3. *Sphenopteris* sp. From McRae's, Hokonui Hills, Southland. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (Rhætic.)

Fig. 4. *Thinnfeldia Feistmanteli* (Gothan). From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (? Rhætic.)

Fig. 5. *Thinnfeldia odontopteroides* (Morr.). From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* Natural size. (? Rhætic.)

Fig. 6. *Thinnfeldia ? lancifolia* (Morr.). From McRae's, Hokonui Hills, Southland. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (? Rhætic.)

Fig. 7. *Sphenopteris otagoensis* sp. nov. From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (? Rhætic.)

Fig. 8. *Sphenopteris owakaensis* sp. nov. From the same locality and in the same collection. $\times$ 3. (? Rhætic.)

Fig. 9. *Sphenopteris* sp. From McRae's, Hokonui Hills, Southland. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (? Rhætic.)

3 X2

2 X $\frac{5}{3}$

1

5

4 X2

6 X2

7 X2

9 X2

8 X3

W Tams, photo.

Thinnfeldia and Sphenopteris.

Plate VI.

Fig. 1. *Tæniopteris arctica* Heer. From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* × 2. (Neocomian.)

Fig. 2. *Tæniopteris vittata* Brongn. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Lower Jurassic.)

Fig. 3. *Tæniopteris vittata* Brongn. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Lower Jurassic.)

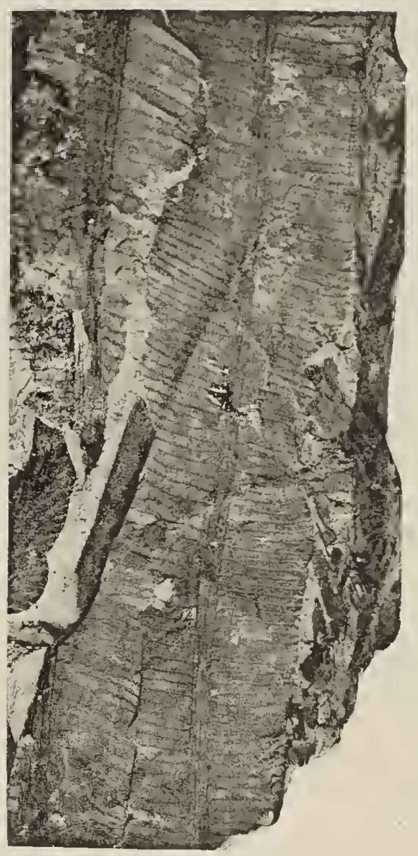
Fig. 4. *Tæniopteris Thomsoniana* sp. nov. (type) and *Elatocladus conferta* (Old. & Morr.). From Mount Potts, Canterbury. *Brit. Mus. (Nat. Hist.).* × 2. (Rhætic.)

Fig. 5. *Tæniopteris Daintreei* McCoy. From the Malvern Hills, Canterbury. *No. 625, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (Lower Jurassic.)

Fig. 6. *Tæniopteris arctica* Heer. From Waikato Heads, Auckland. *V. 11632 Brit. Mus. (Nat. Hist.).* Natural size. (Neocomian.)

3

2



1 X2

5

3

4 X2

6

W Tams, photo.

Tæniopteris and Elatocladus.

Plate VII.

Fig. 1. *Nageiopsis longifolia?* Font. From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* $\times \frac{3}{2}$. (Neocomian.)

Fig. 2. *Nageiopsis longifolia?* Font. From the same locality. *V. 11643, Brit. Mus. (Nat. Hist.).* Natural size. (Neocomian.)

Fig. 3. *Microphyllopteris pectinata* (Hect.). From the same locality. *V. 11640, Brit. Mus. (Nat. Hist.).* Natural size. (Neocomian.)

Fig. 4. *Microphyllopteris pectinata* (Hect.). From the same locality. *New Zeal. Geol. Surv. Coll.* $\times 2$. (Neocomian.)

Fig. 5. *Microphyllopteris pectinata* (Hect.) and *Tæniopteris arctica* (Heer). From the same locality. *V. 11628, Brit. Mus. (Nat. Hist.).* $\times \frac{7}{4}$. (Neocomian.)

Fig. 6. *Microphyllopteris pectinata* (Hect.). Part of Fig. 11, enlarged to show the nervation. *New Zeal. Geol. Surv. Coll.* $\times 4$. (Neocomian.)

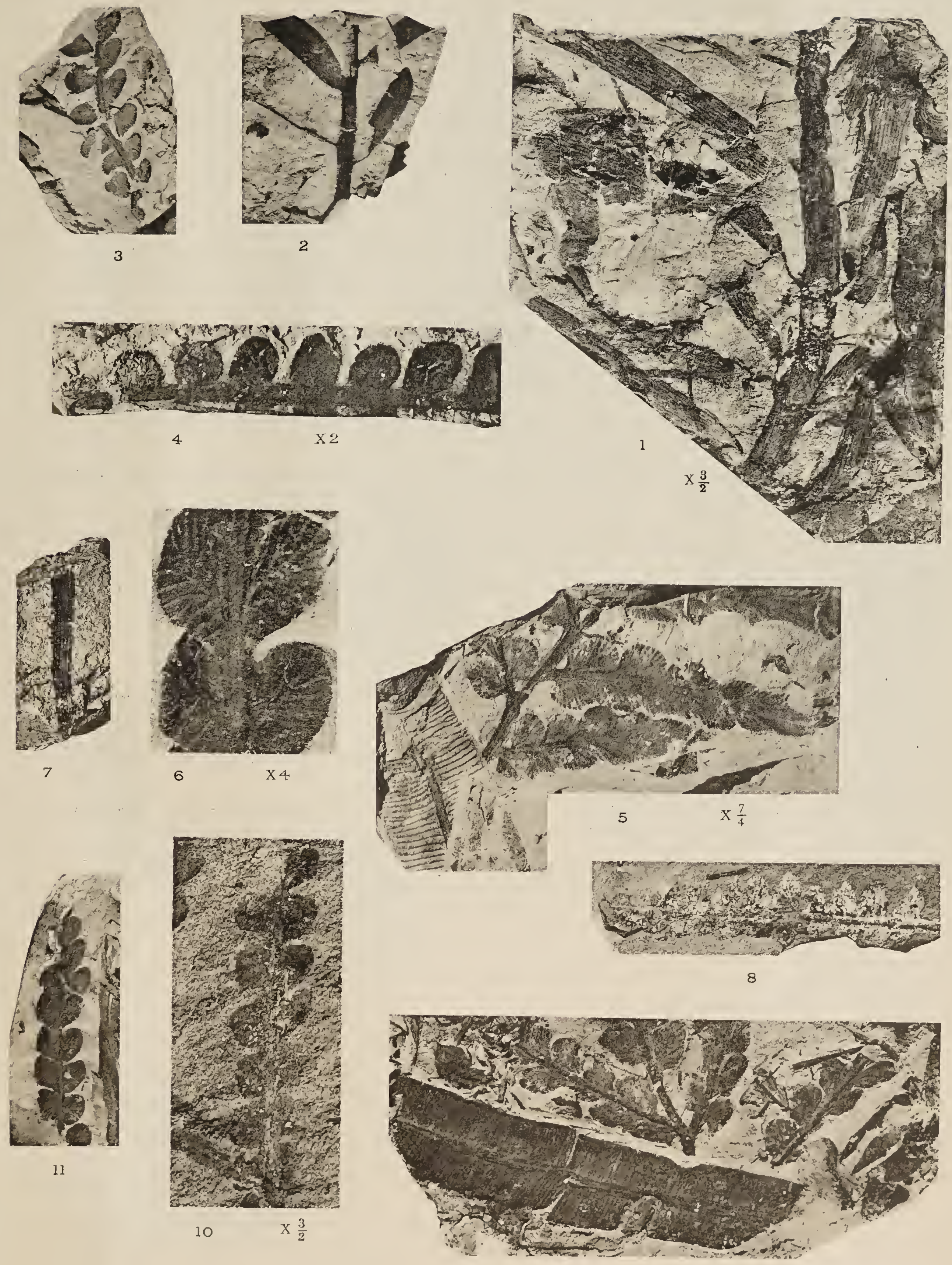
Fig. 7. Pinnule of a Cycadophyte. From Mokoia, Gore, Southland. *No. 606, For. Mes. Plant Coll., Sedgwick Mus., Camb.* Natural size. (Lower Jurassic.)

Fig. 8. *Microphyllopteris pectinata* (Hect.). From Mataura Falls, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Middle Jurassic.)

Fig. 9. *Microphyllopteris pectinata* (Hect.) and *Tæniopteris arctica* Heer. From Waikato Heads, Auckland. *V. 11631, Brit. Mus. (Nat. Hist.).* $< \frac{7}{5}$. (Neocomian.)

Fig. 10. *Microphyllopteris pectinata* (Hect.). From Mataura Falls. Southland. *New Zeal. Geol. Surv. Coll.* $\times \frac{3}{2}$. (Middle Jurassic.)

Fig. 11. *Microphyllopteris pectinata* (Hect.). From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* Natural size. (Neocomian.)



W. Tams, photo.

Nageiopsis, Microphyllopteris and Tæniopteris.

Plate VIII.

Fig. 1. *Dictyophyllum obtusilobum ?* (Braun). From Mokoia, Gore, Southland. *No. 607. For. Mes. Plant Coll., Sedgwick Mus., Camb.* Natural size. (? Lower Jurassic.)

Fig. 2. *Nilssonia compta ?* (Phill.). From the same locality, and No. 608 in the same collection. Natural size. (Lower Jurassic.)

Fig. 3. *Nilssonia compta ?* (Phill.). From the same locality, and No. 609 in the same collection. Natural size. (Lower Jurassic.)

Fig. 4 *Tæniopteris Thomsoniana* sp. nov. From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* Natural size. (Rhætic.)

Fig. 5. *Araucarites cutchensis* (Feist.). From Mokoia, Gore, Southland. *No. 610. For. Mes. Plant. Coll., Sedgwick Mus., Camb.* × $\frac{3}{2}$. (Lower Jurassic.)

Fig. 6. *Elatocladus conferta* (Old. & Morr.). From the same locality, and No. 611 in the same collection. Natural size. (Lower Jurassic.)

Fig. 7. *Tæniopteris Thomsoniana* sp. nov. From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* Natural size. (Rhætic.)

Fig. 8. *Nilssonia elegans* sp. nov. From Mataura Falls, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Middle Jurassic.)

Fig. 9. *Nilssonia compta ?* (Phill.). From Mokoia, Gore, Southland. *No. 609. For. Mes. Plant Coll., Sedgwick Mus., Camb.* Natural size. (Lower Jurassic.)

Fig. 10. *Dictyophyllum*, cf. *D. obtusilobum* (Braun). From the same locality, and No. 626 in the same collection. Natural size. (Lower Jurassic.)

T. A. Brock del.

Dictyophyllum, Nilssonia, Tæniopteris etc.

Plate IX.

Fig. 1. *Nilssonia elegans* sp. nov. From Mataura Falls, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Middle Jurassic.)

Fig. 2. *Pterophyllum matauriensis* Hect. Enlarged to show the nervation. From the same locality and in the same collection. $\times \frac{5}{2}$. (Middle Jurassic.)

Fig. 3. *Nilssonia elegans* sp. nov. From the same locality and in the same collection. $\times 2$. (Middle Jurassic.)

Fig. 4. *Tæniopteris crassinervis* (Feist.). An apical portion. From the same locality. *V. 11671, Brit. Mus. (Nat. Hist.).* Natural size. (Middle Jurassic.)

1

2 X $\frac{5}{2}$

3 X 2

4

W Tams, photo.

Nilssonia, Pterophyllum, Tæniopteris.

Plate X.

Fig. 1. *Tæniopteris crassinervis* (Feist.). A complete frond. From Mataura Falls, Southland. *New Zeal. Geol. Surv. Coll.* Reduced to $\frac{7}{11}$. (Middle Jurassic.)

Fig. 2. *Tæniopteris crassinervis* (Feist.). A young frond. From the same locality and in the same collection. Natural size. (Middle Jurassic.)

Fig. 3. *Tæniopteris crassinervis* (Feist.). A basal portion from the same locality. *V. 11679, Geol. Dept. Brit. Mus. (Nat. Hist.).* Natural size. (Middle Jurassic.)

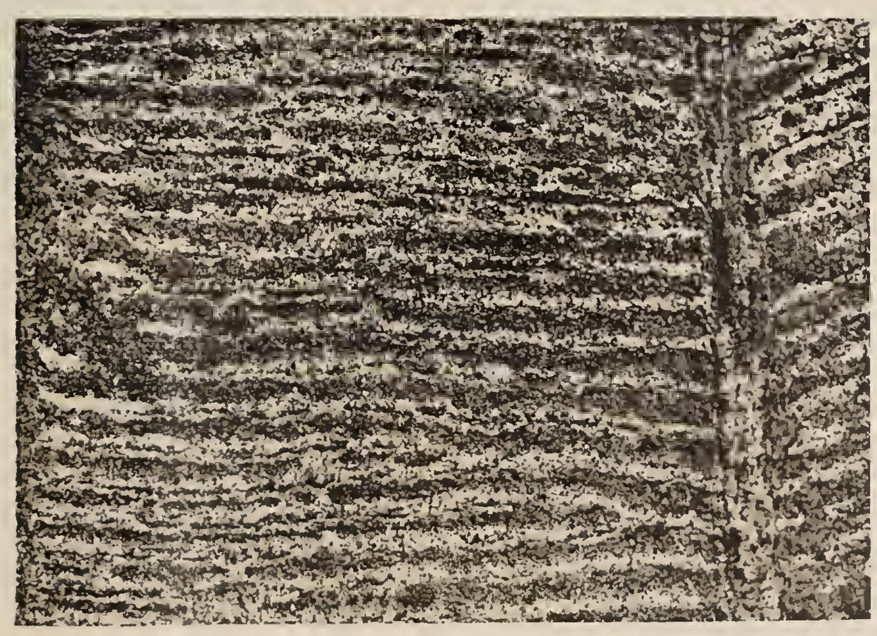
Fig. 4. Roots: From the same locality, and V. 11678 in the same collection. Natural size. (Middle Jurassic.)

Fig. 5. *Tæniopteris crassinervis* (Feist.). Part of a frond, enlarged to show the nervation. From the same locality, and V. 11677 in the same collection. × 3. (Middle Jurassic.)


3


2


1 X $\frac{7}{11}$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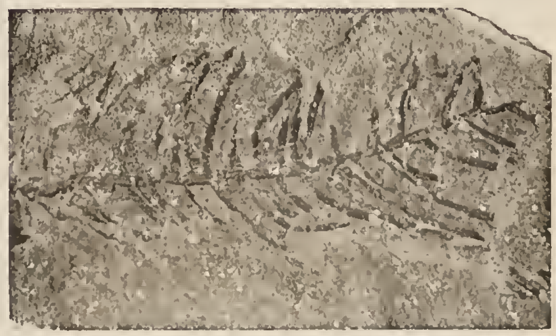

4

W Tams, photo.

Tæniopteris.

Plate XI.

Fig. 1. *Ptilophyllum acutilobum* Morr. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* $\times$ 2. (Middle Jurassic.)

Fig. 2. *Ptilophyllum acutilobum* Morr. From the same locality and in the same collection. $\times \frac{2}{3}$. (Middle Jurassic.)

Fig. 3. *Baiera robusta* sp. nov. From Mount Potts, Canterbury. *Brit. Mus. (Nat. Hist.)*. $\times \frac{7}{6}$. (Rhætic.)

Fig. 4. *Baiera robusta* sp. nov. From the same locality and in the same collection. $\times \frac{2}{3}$. (Rhætic.)

Fig. 5. *Ptilophyllum acutilobum* Morr. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* $\times \frac{2}{3}$. (Middle Jurassic.)

Fig. 6. *Carpolithus McKayi* sp. nov. From Wairoa Gorge, Mount Heslington, Nelson. *New Zeal. Geol. Surv. Coll.* $\times \frac{2}{3}$. (? Rhætic.)

3 x $\frac{7}{4}$

2

1 X 3

4

6

5

W. Tams, photo.

Ptilophyllum, Baiera, Carpolithus.

Plate XII.

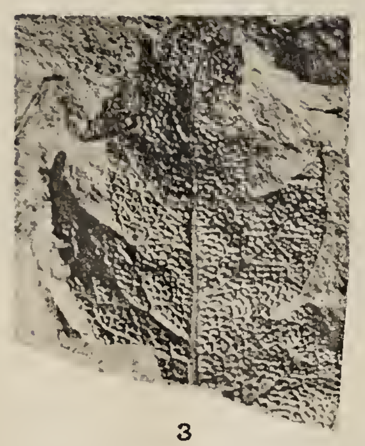
Fig. 1. *Pterophyllum mataurienses* Hect. From Mataura Falls, Southland. *V. 11675, Brit. Mus. (Nat. Hist.).* × $\frac{2}{3}$. (Middle Jurassic.)

Fig. 2. *Dictyophyllum acutilobum* (Braun). From the same locality. *New Zeal. Geol. Surv. Coll.* Very slightly reduced. (Middle Jurassic.)

Fig. 3. *Dictyophyllum acutilobum* (Braun). From the Clent Hills, Canterbury. *New Zeal. Geol. Surv. Coll.* × $\frac{2}{3}$. (Rhætic.)

Fig. 4. *Dictyophyllum acutilobum* (Braun). From Mataura Falls, Southland. *New Zeal. Geol. Surv. Coll.* Natural size. (Middle Jurassic.)

Fig. 5. Stems of ? *Ptilophyllum* sp. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* × $\frac{2}{3}$. (Middle Jurassic.)



3

2

1

5

4 $\times \frac{3}{2}$

W. Tams, photo.

Pterophyllum and Dictyophyllum

Plate XIII.

Fig. 1. *Pagiophyllum peregrinum* (L. & H.). From Mataura Falls, Southland. *New Zeal. Geol. Surv. Coll.* $\times \frac{2}{3}$. (Middle Jurassic.)

Fig. 2. *Obscure ? fructification.* From Waikato Heads, Auckland. *New Zeal. Geol Surv. Coll.* $\times \frac{4}{3}$. (Neocomian.)

Fig. 3. *Obscure ? fructification.* From the same locality and in the same collection. Natural size. (Neocomian.)

Fig. 4. *Araucarites cutchensis* Feist. From Mokoia, Gore, Southland. *No. 610, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* $\times \frac{2}{3}$. (? Lower Jurassic.)

Fig. 5. *Obscure ? fructification.* From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* Natural size. (Neocomian.)

Fig. 6. *Obscure ? fructification.* From the same locality and in the same collection. Natural size. (Neocomian.)

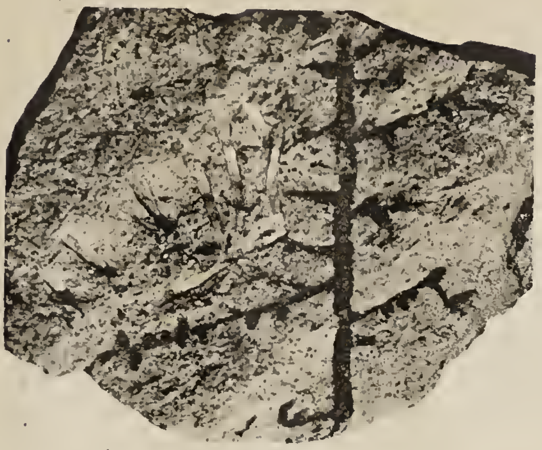
Fig. 7. *Stachyotaxus* sp. From Mokoia, Gore, Southland. *No. 612, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* $\times \frac{3}{2}$. (? Lower Jurassic.)

Fig. 8. *Brachyphyllum* sp. From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* Natural size. (? Rhætic.)

Fig. 9. *Elatocladus* sp. From Waikawa, Southland. *New Zeal. Geol. Surv. Coll.* $\times \frac{7}{4}$. (Middle Jurassic.)

Fig. 10. *Brachyphyllum* sp. From Owaka Creek, Catlin's River, Otago. *New Zeal. Geol. Surv. Coll.* $\times 2$. (? Rhætic.)

Fig. 11. *Elatocladus conferta* (Old. & Morr.). From the Malvern Hills, Canterbury. *No. 621, For. Mesoz. Plant Coll., Sedgwick Mus., Camb.* Natural size. (Lower Jurassic.)



3 $\times \frac{3}{2}$

2 X2

1

4

5 $\times \frac{3}{2}$

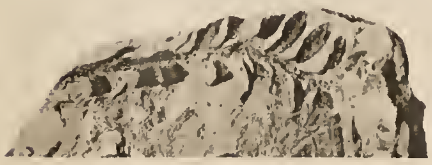
6 $\times \frac{3}{2}$

10 X2

7 $\times \frac{3}{2}$

9 $\times \frac{7}{4}$

8



11

W. Tams, photo.

Pagiophyllum, Stachyotaxus, Brachyphyllum etc.

Plate XIV.

Leaf of *Artocarpidium Arberi* Laur. seen at *a* (upper right-hand corner), another leaf of the same species seen at *b* (lower right-hand corner), and a leaf of *Phyllites* sp. seen at *c* (rather more than half-way up the left-hand side), with pinnæ of *Cladophlebis australis* (Morr.). From Waikato Heads, Auckland. *New Zeal. Geol. Surv. Coll.* × 2. (Neocomian.)

W Tams, photo.

Artocarpidium & Cladophlebis.

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